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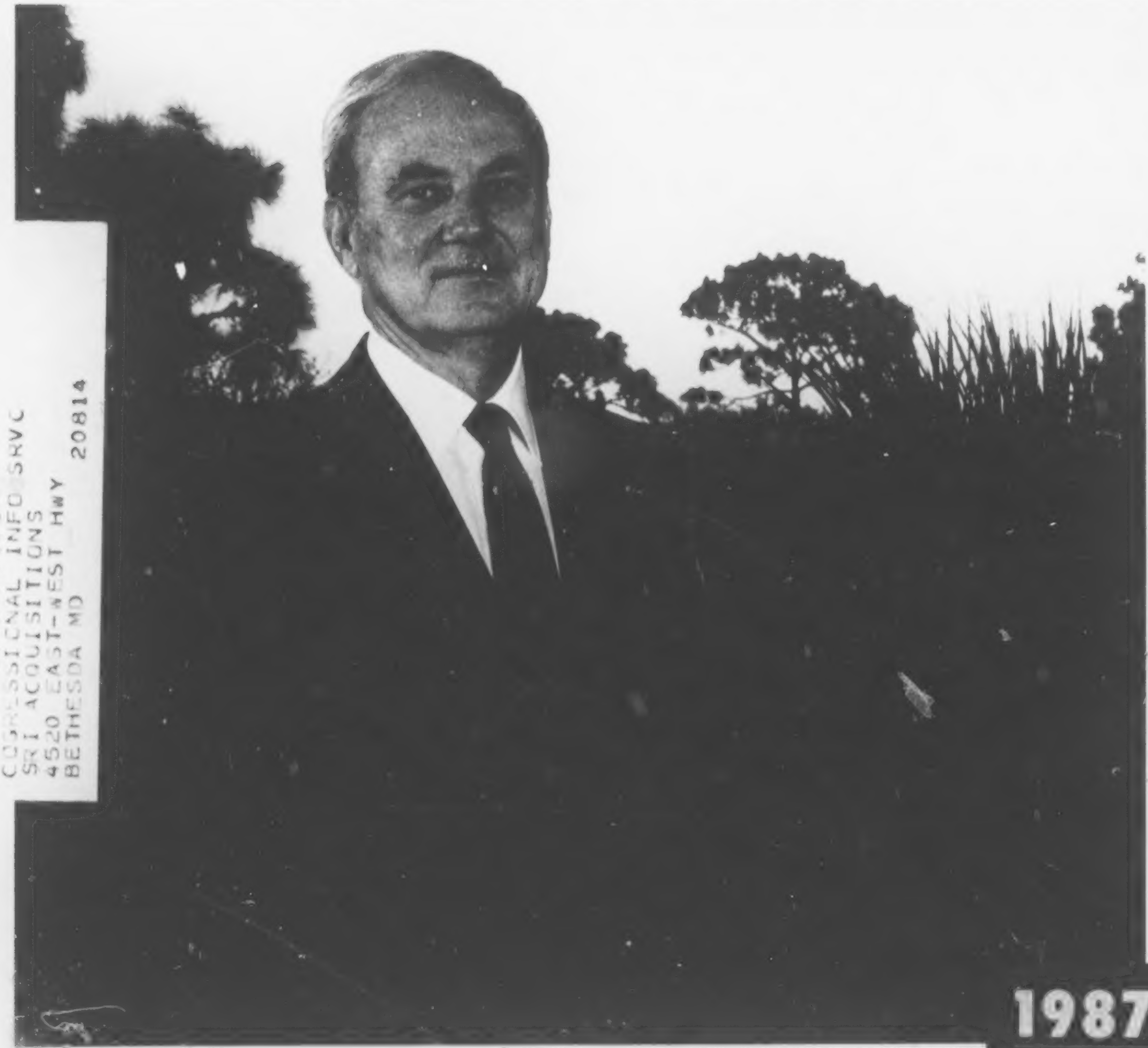
DECEMBER 10, 1986

FIVE DOLLARS

Electronic Business

DSPs: Clear signals for a rising market

Winning strategies for doing business in Europe



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John T. Hartley: The new force at Harris

1987 Services Directory

Electronic Business

VOL. 12, NO. 23

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THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY

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Cover photo/Greg Leary

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BPA ABP

Fujitsu plus Fairchild: hope for profits and more ASICs

The summer was sunny for semiconductor sales in dollars, but not in yen

Fujitsu Ltd.'s investment in — and proposed acquisition of — Fairchild Semiconductor Corp. summarizes the status of the semiconductor market: the yen's jump, the profits' crunch and the ASIC's growth. In Japan, Fujitsu's homeground, revenue in yen has declined much faster than expenses. Japanese chip makers, then, have followed their American counterparts in reporting red ink for 1986. Fujitsu already is the second largest supplier of metal-oxide semiconductor (MOS) gate arrays, the largest segment of the application-specific integrated circuits market, and Fairchild has a good position in emitter-coupled logic (ECL) gate arrays for military applications.

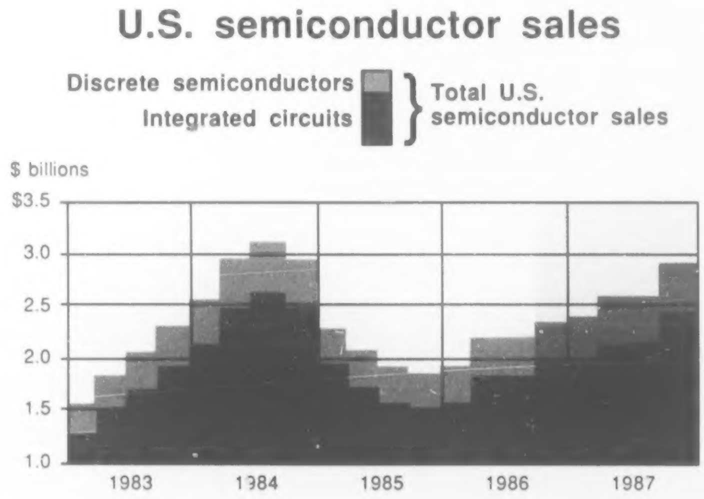
But just as the Japanese market for semiconductors has slowed its growth in dollars (while declining in yen), the U.S. market is picking up. Shipments to U.S. customers in the third quarter of 1986 exceeded last year's by 16%. Moreover, the summer months notwithstanding, third quarter shipments held even with respect to the previous quarter's shipments, which, in turn, were the highest since the first quarter of 1985. This is a good performance; it shows a slow but steadily growth.

Cahners Economics expects growth to continue. It forecasts a fourth quarter strong enough to push 1986 U.S. shipments past 1985's by 6% to 7%. Jack Beedle of In-Stat, a market researcher who specializes in semiconductors, believes it is too late into the year to come up with anything more than 4% growth. Another semiconductor market specialist, Integrated Circuit Engineering Corp., is in the middle at 6%.

In-Stat's vice president of operations, Jim Feldham, deduces that Fujitsu's move is prompted by the attractiveness of the ASICs market in the United States. The figures support his assertion, because sales by companies that are in the ASICs market have grown much faster than for other semiconductors. For example, Intel Corp., which only recently entered the gate arrays market through an arrangement with IBM, saw its sales grow by only 4% in the third quarter of 1986. Motorola Semiconductor Products Inc., a very broad-based producer of semis, did better than all other large competitors with 21% growth. By contrast, sales by LSI Logic, the leading manufacturer of gate arrays, increased in the third quarter by 34% over last year.

The Semiconductor Industry Association's U.S. book-to-bill ratio for MOS and CMOS ICs, which is strongly influenced by demand for ASICs, had reached 1.16 and 1.20 respectively at midyear and continued to improve in the second half, promising sustained growth for shipments. For all semis, the U.S. book-to-bill ratio turned up in September after declining during the summer. This has encouraged Cahners to forecast 20% growth for 1987. In-Stat says only 6%.

ALBERTO SOCOLOVSKY



Historical data: Semiconductor Industry Association
Forecast: Cahners Economics

Slower growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For the year, production is expected to be up a scant 0.9% from last year. Next year, steady improvements are forecast thoughout the year pushing production up 3.9% in 1987.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1986 should be 0.9% above 1985.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

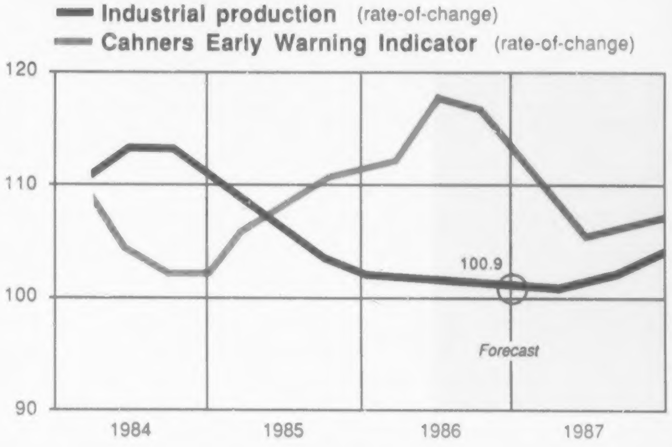
Defense and space equipment

Government spending constraints have begun to curtail the performance of the defense and space industries. Although production of such equipment rose steadily during the first nine months of this year, there was a large decrease in the industry's underlying rate of year-to-year growth. It has hovered in a range of 5% to 5.5% since June, down from about 9.5% at the start of 1986. High order backlogs will enable manufacturers to maintain the current growth rate for several more months, but another cooling off period after mid-1987 is expected. Look for production to post an overall gain of 5.6% this year, 2.8% next year and just 0.5% in 1988.

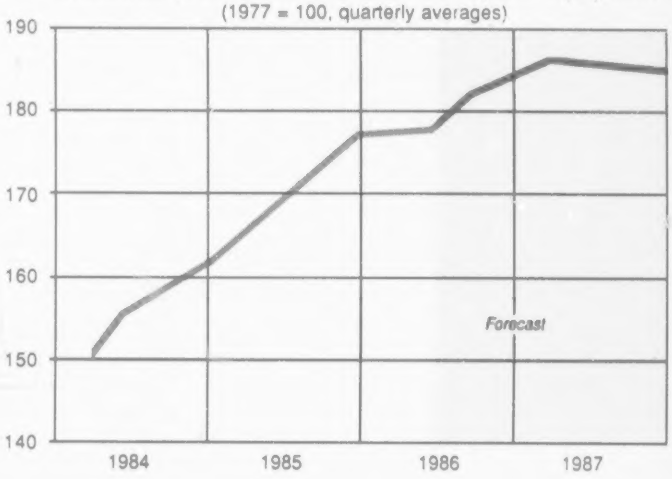
Aircraft and parts

Aircraft manufacturers boosted their production levels by 2.0% in the second quarter. This was a healthy pace of increase but was down nearly a full percentage point from the previous quarter. Preliminary reports for the third quarter point to another gain on the order of 2%. If this occurs, then manufacturing activity for the first nine months of 1986 will have exceeded the year-ago pace by a sizable 12.9% margin. Defense budget cuts are still expected to reduce the industry's growth performance in the late 1980s. After a gain of 11.9% (in real terms) this year, production is expected to rise 4.1% in 1987 and then dip 1% or 2% in 1988.

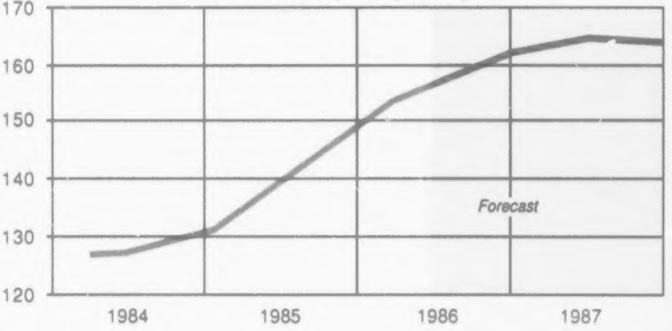
Economic indicators



Industrial production: Defense and space equipment
(1977 = 100, quarterly averages)



Industrial production: Aircraft and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Office and computing equipment

(SIC 357)

New orders

Manufacturers of computers and office machines received $11.85 billion in orders in the second quarter of 1986, up from $10.23 billion in the prior quarter. But total first half orders still show a shortfall of nearly 24% from a year earlier. Declines in U.S. industrial growth and concerns over tax reform were largely responsible for this weakness, prompting buyers to postpone all but the most necessary equipment purchases. Orders should pick up somewhat in the second half, which is typically the strongest selling season. However, the negative effects of tax changes will prevent substantial improvements from occurring until at least the middle of next year. Following an overall loss of 10.4% to $48.5 billion in 1986, orders are expected to rebound 15.3% in 1987 and 16.4% in 1988.

Shipments

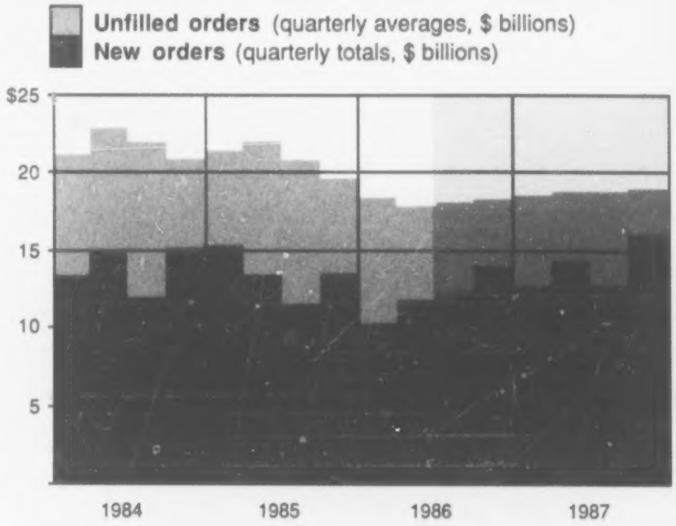
Shipments were valued at approximately $12.31 billion in this year's second quarter, a gain of 16.8% over the first quarter's pace. However, preliminary reports for the third quarter point to a leveling off in activity and support expectations of disappointing near-term growth. Sluggish U.S. business investment and extremely competitive pricing are expected to dampen the market's performance over the balance of 1986 and into early 1987. This will cause shipments to fall 9.3% to $49.8 billion in the current year. Manufacturers will recoup some of that loss in 1987.

Unfilled orders

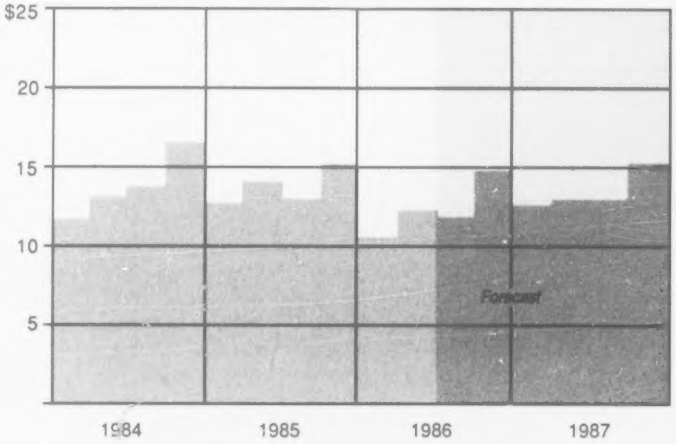
Faced with a long and unusually severe decline in orders, manufacturers of computers and office machines have been drawing down their backlogs almost without interruption since mid-1984. By this June, they had been cut nearly 23% to merely $18 billion (the lowest level in more than three years). Backlogs are expected to stabilize in the second half of this year, but will still show an overall annual loss of 13.5% compared with 1985. Backlogs should edge up about 3.3% in 1987.

Inventory-to-shipment ratio

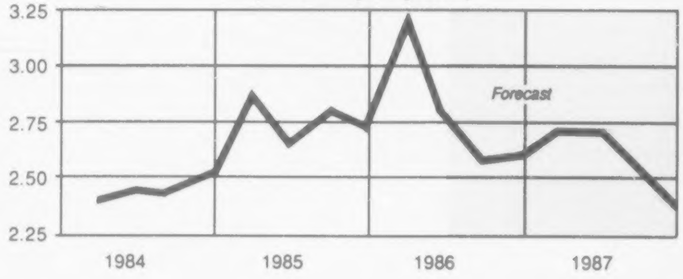
The ratio of industry inventories to shipments (I/S) reached a 10-year high of 3.23 in this year's first quarter, an unusually high level which indicated a need for manufacturers to liquidate inventory. This is precisely what happened in the second quarter; inventories were cut to an average of just $11.5 billion, the lowest level since early 1984 and down approximately 4.4% from the prior quarter. At the same time, shipments showed an increase of 11.7% after seasonal adjustment. These divergent trends drew the industry's I/S ratio back to a more comfortable 2.77 level. The I/S ratio is expected to fluctuate near the current rate for most of the coming year.



Office and computing equipment: Shipments
(quarterly totals, $ billions)



Office and computing equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Communication equipment

(SIC 366)

New orders

New orders for communication equipment fell to $15.43 billion in the second quarter, from $18.81 billion in the first quarter of the year, due almost entirely to a drop in demand for defense-related products. Although cutbacks in defense budget authority will continue to restrain the market's performance over the next several years, overall order activity will be more heavily influenced by trends in the larger nondefense sector. That area has recently shown signs of a slight pickup, and will grow even more rapidly if domestic business investment turns up as expected in late 1987. Following a loss of 3.6% to $67.0 billion in 1986, orders are forecast to increase 6.5% next year and 13.7% in 1988.

Shipments

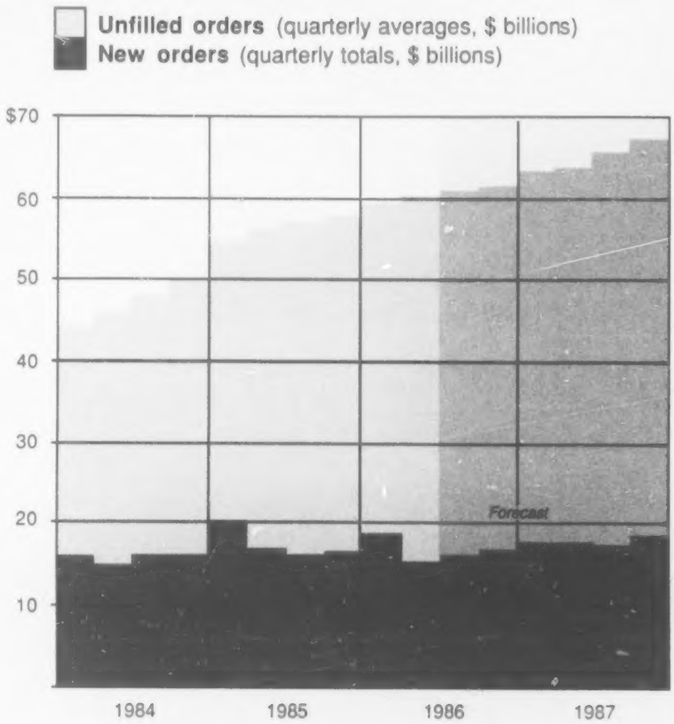
Orders for both defense and nondefense products were sluggish in early 1986, but backlogs in the former area were at a near-record level during the period. This enabled manufacturers to sustain a fairly brisk pace of shipment activity. Shipments reached a second-quarter total of $16.2 billion, an increase of 4.5% over the figure in the first quarter. We expect further gains in the defense area to buoy the industry during late 1986 and early 1987, with a rebound in the nondefense sector causing growth to accelerate after the middle of next year. Shipments will increase 4.8% to $65.5 billion this year, post another modest gain of 5.6% in 1987 and then jump 9.4% in 1988.

Unfilled orders

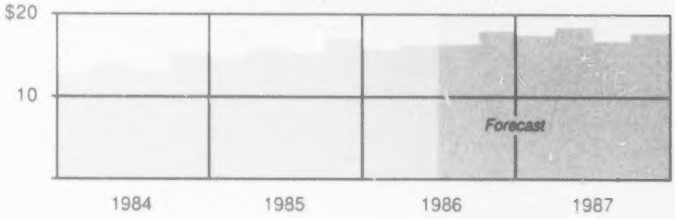
Manufacturers' backlogs increased slightly in the second quarter, to an average of $60.1 billion from $59.7 billion in the previous three months. But the rise masked a sharp slowdown in the market's underlying rate of growth: backlogs were up just 6.2% on a year-to-year basis in June, less than half of the growth rate which was reported just six months earlier. Sluggish capital spending and a cooling off in the defense sector will cause backlogs to grow just 7.1% this year, the worst performance since 1973. This should be followed by gains of 7.5% and 9.1% in 1987 and 1988, respectively.

Inventory-to-shipment ratio

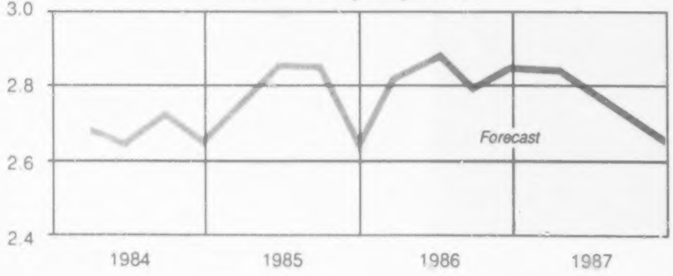
The ratio of manufacturers' inventories to shipments continued to climb in the second quarter, reaching an average of 2.87. This was the highest level in 4.5 years, an indication that inventories are probably undesirably high. We expect manufacturers to make some headway against this problem during the next two to three quarters, with more pronounced improvements coming once shipments begin to accelerate in late 1987. The ratio should be down to a more comfortable range of 2.6 to 2.65 by the end of next year.



Communication equipment: Shipments
(quarterly totals, $ billions)



Communication equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Competition worries Taiwanese manufacturers

The biggest U.S. exporter of the Orient's four Tiger countries may turn from predator to prey

The idea that Taiwan's $8-billion electronics industry faces any problems would prompt a hollow laugh from many U.S. consumer-electronics gear and computer-peripherhal manufacturers being battered by Taiwanese competition.

A look at 1985 international trade statistics would only add to their derision. Taiwan, last year, exported $3.2 billion in electronics to the United States, leading the other three Tiger countries (Hong Kong, Singapore and South Korea) and trailing only Japan in such exports. Last year, its electronics trade notched a surplus of $2.4 billion with the United States and $600 million with Europe. That trade imbalance is expected to widen further by the end of this year as Taiwan's increasingly strong information-products segment grows more sophisticated.

Yet some Taiwan-based executives caution that the country's export-led growth is a fragile success, constantly under threat from mounting protectionism from richer countries and competition from poorer countries keen to "out-Taiwan" Taiwan. These executives fear, too, that the plethora of 2,300 small, mostly family-owned businesses in Taiwan's electronics industry lack the resources to compete in the sophisticated products segment with giant companies from Japan, Korea and the United States.

Says James R. Klein, president of General Instrument of Taiwan Ltd., which manufactures power semiconductors, relays and other components: "In the past [Taiwanese firms] were order takers, with relatively little marketing expertise or brand identification. To move into high technology they will have to invest more and keep on investing more." Adds Hsu Kuo-an, director of the island nation's Industrial Development Board (IDB), "We have manufacturing prowess, not marketing prowess, that's the problem."

The growth of Taiwan's industry over the past decade was fueled by efficient assembly based on productive cheap labor and readily available, cheap investment finance. Large multinational companies built plants to assemble consumer products in volume, while many local enterprises rushed to meet market requirements with low-cost products.

The result is a hotbed of activity today with little regard for tomorrow. A survey done last year by the Council for Economic Planning and Development (CEPD), a Taiwan government agency, shows that the electronics industry consists of 136 companies with collective sales of over $10 million, 60% of these have foreign collaboration. The country has 542 firms with sales of between $1 million and $10 million; and it has over 1,400 firms with sales of less than $1 million.

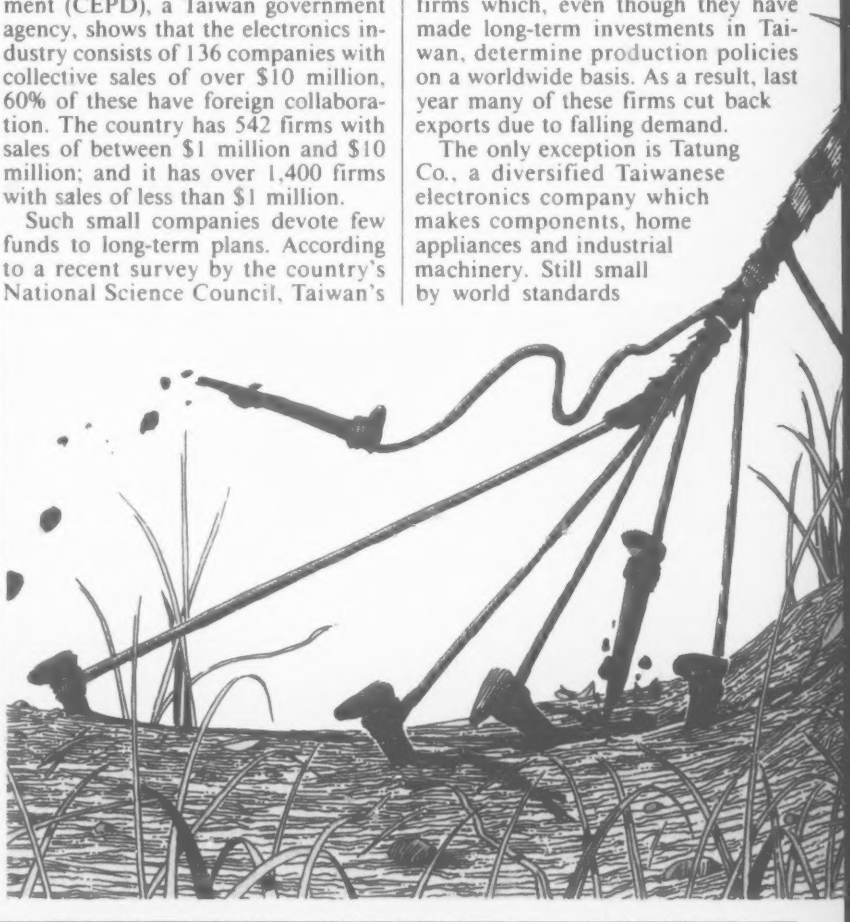
Such small companies devote few funds to long-term plans. According to a recent survey by the country's National Science Council, Taiwan's firms on average spend just 0.44% of sales on research and development — a tiny fraction compared with the industrialized world's percentage spent on R&D.

Concludes Chii-ming Viin, the director responsible for the electronics industry segment of the IDB, "I think a weakness of the electronics industry is that it lacks the big enterprises capable of developing capital-intensive products."

Multinational ambitions

This lack makes Taiwan heavily dependent on foreign-controlled companies. Most of its major electronics exporters are American-managed firms which, even though they have made long-term investments in Taiwan, determine production policies on a worldwide basis. As a result, last year many of these firms cut back exports due to falling demand.

The only exception is Tatung Co., a diversified Taiwanese electronics company which makes components, home appliances and industrial machinery. Still small by world standards

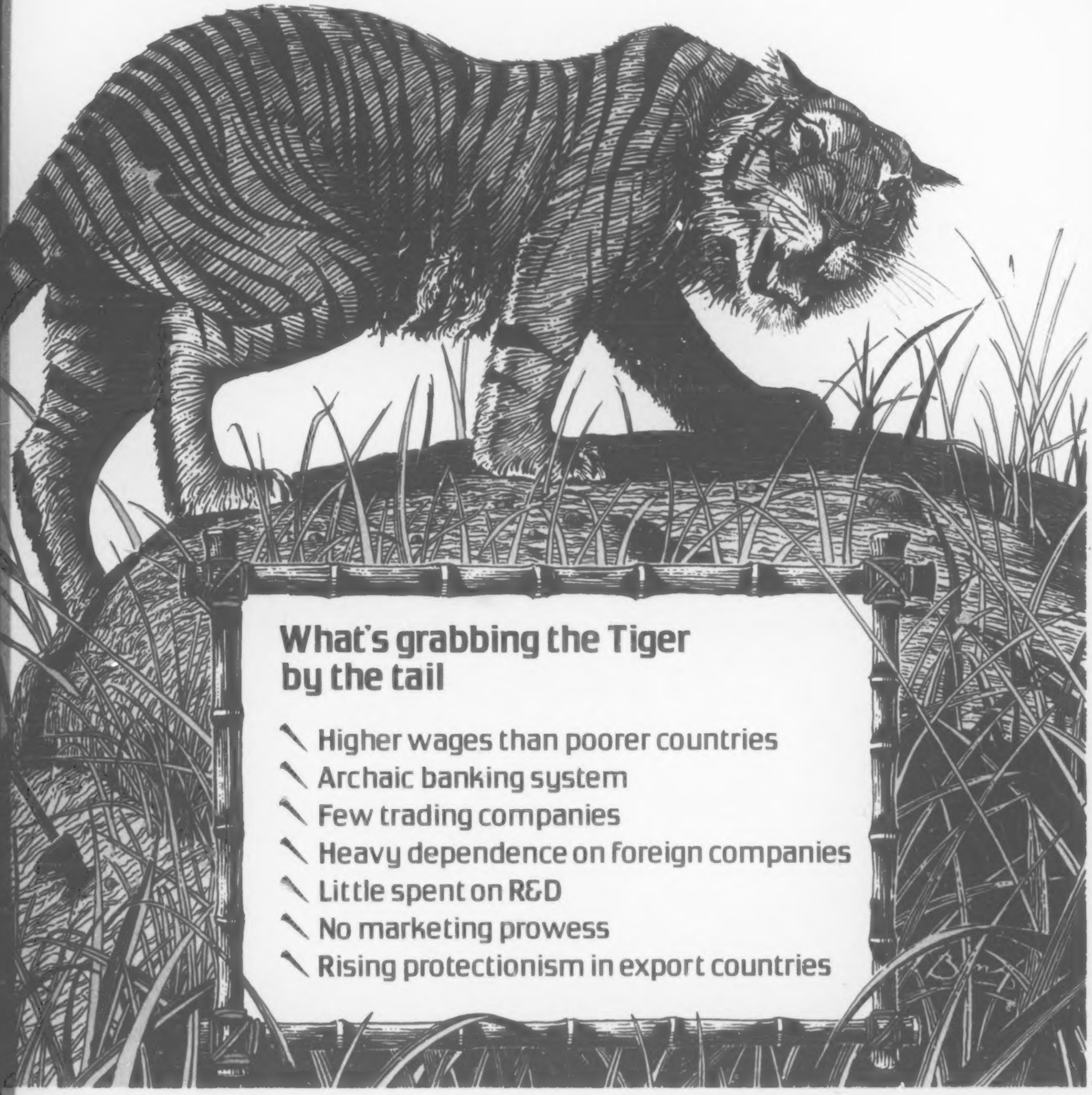


with sales of less than $1 billion last year, it is nevertheless striving to become a true multinational player.

Tatung's general manager for marketing, A.C. Wang, says that his company has boosted its R&D spending from 1% of sales to almost 3% of sales over the last decade. To establish international brand-identity and overcome trade frictions, the firm set up factories to build consumer electronic equipment in Atlanta and Long Beach, Calif., in the 1970s. In 1981, it also established a presence in Great Britian with a factory, now based in Telford, England, capable of building 300,000 color televisions a year, in addition to a range of other consumer products. Says Wang: "Tatung [Britian] will be a good corporate citizen. It will now gradually increase exports from the U.K. to the rest of the European Economic Community."

Another Taiwanese firm aiming to boost its international identity is Multitech Industrial Corp., which recently entered the U.S. business computer market with its IBM PC AT-compatible Accel 900. It is spending $1 million on advertising, and it hopes to sell products worth up to $75 million in the United States this year.

But these two companies are the exceptions. Efforts by the Taiwanese government to promote large-scale trading houses, along the lines of the



What's grabbing the Tiger by the tail

- Higher wages than poorer countries
- Archaic banking system
- Few trading companies
- Heavy dependence on foreign companies
- Little spent on R&D
- No marketing prowess
- Rising protectionism in export countries

Christopher Bing

Japanese model, have so far proved to be largely unsuccessful. As a result, the government is now engaged in a process of persuasion, gentle coercion and exhortation within the domestic manufacturing community to promote innovation and more marketing savvy.

It is a delicate balance. According to Robert H.C. Tsao, president of Taiwan chip maker United Microelectronics Corp. (UMC): "If you take a look at the growth or at the competitive prices it's hard to say there's a problem. Being small makes the firm dynamic."

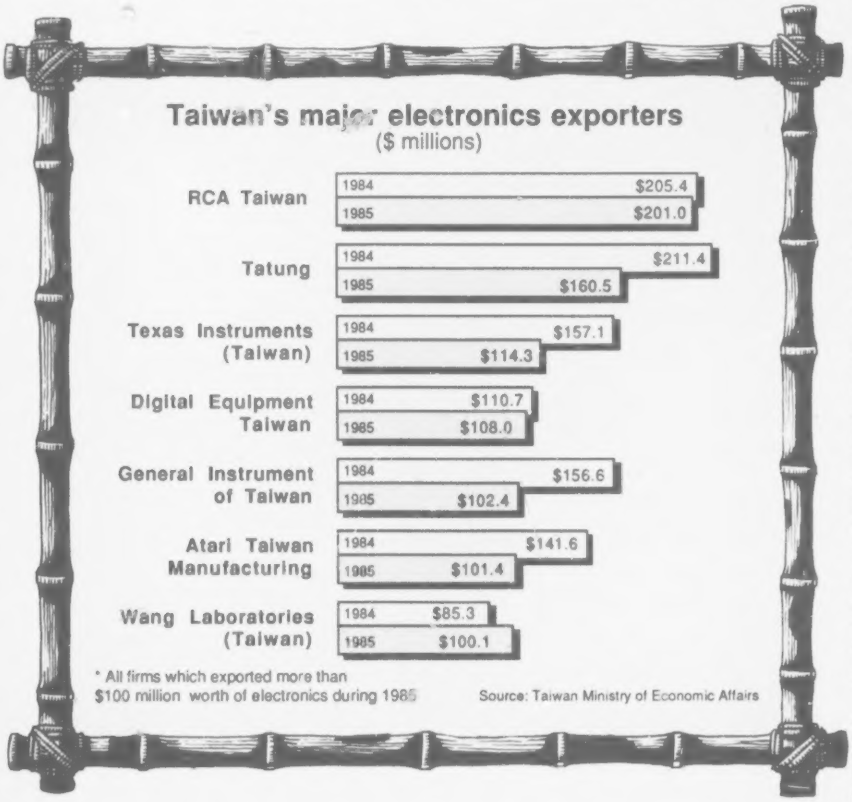
However, he admits, many sectors of electronics manufacturing, such as integrated circuits (ICs), require additional investment. He says that UMC, Taiwan's first domestic IC fabricator, spends over 20% of sales on capital investment and 10% of sales on R&D. But, he argues, its rapid success and high profitability have been largely due to surging demand by local users, notably in the information products sector, which accounts for 50% of the sales. In the first eight months of 1986, UMC's sales reached $45 million, compared with $35 million for the whole of 1985. Tsao says that UMC has recorded profits of around 25% of sales almost since UMC's first started production in 1982. It is now embarking on a five-year, $150-million project to build a new, 6-inch very large-scale integration (VLSI) wafer-fabrication plant.

IC eloquence

In a way UMC, itself, is an eloquent symbol of the Taiwanese government's approach to industrial planning. Ten years ago, the government set up the Electronics Research and Service Organization (ERSO) and charged it with undertaking fundamental research and setting up a semiconductor fabrication industry. Initially, UMC was partially state-funded via ERSO, but has since been managed as an independent private firm.

Currently ERSO is helping to set up a second IC fabricator — the Taiwan Semiconductor Manufacturing Corp. — in collaboration mainly with Philips, and with Matsushita to a smaller degree.

The government, at present, funds almost half of the electronics R&D, especially through its 2,000-strong research staff at the Industrial Technology Research Institute. ITRI seeks to channel technology to private firms for commercial exploitation.



* All firms which exported more than $100 million worth of electronics during 1985

Source: Taiwan Ministry of Economic Affairs

Also, Taiwan is taking the initiative and is setting up a 5,000-acre science-based industrial park at Hsin-Chu, 70 kilometers south of the capital, Taipei. Over 50 firms have now set up business in the park, although there are still acres of vacant space. Most have been founded by expatriate Chinese professionals who have returned from America. But so far, no Japanese firms have been attracted to Hsin-Chu, which some observers reckon reflects anxiety over the protection of intellectual property rights in Taiwan. To overcome this problem, the Taiwanese Interior Ministry has signed reciprocal copyright pacts with Britain, Spain and the United States and hopes to conclude one with West Germany soon.

But building a science park will not overcome some of the structural problems which will hinder Taiwan's bid to compete in knowledge-intensive industries. To boost R&D spending the government is just setting up a scheme whereby all firms must devote between 0.5% and 1.5% of sales to R&D, depending on the industry involved. Any firm that fails to spend its quota will have to forfeit the difference to the government — which will use it for other R&D. Complains the IDB's Hsu: "We have a very solid foundation of electronics but we lack the R&D."

In the bank

Another major problem is Taiwan's archaic banking system. Says one international banker: "Their industry is headed for the 1990s, but their banks are stuck in the 1950s." This is partly because Taiwan's exporters, awash with cash, finance their investments largely through internally generated profits, circumventing the conventional banking system. Consequently, efficient capital markets and industrial financing institutions have been poorly developed. But, now, government-sponsored efforts are under way to ease this problem. The council for Economic Planning and Development has approved a tax-relief plan for investment in high-technology industries, while the Ministry of Finance has approved the formation of six venture capital companies in the last two years in an attempt to mobilize risk capital.

The importation of such policies will be matched by continuing encouragement of direct foreign investment. GI's Klein, who is also chairman of the Asia-Pacific Council of American

Chambers of Commerce, argues that Taiwan offers an unusually open "Welcome Mat" to foreign firms and — unlike many other Asian countries — allows 100% foreign equity ownership and great freedom of operation. Says Klein: "American firms have brought technology in and trained local engineers. There's been a constant spin off of expertise, talent and technology."

Despite this influx, most of the foreign-owned plants in Taiwan are principally assembly operations, which will lose their comparative advantage as Taiwan's labor costs rise relative to other Asian locations' costs.

So the Taiwanese government is using its purchasing leverage to force foreign firms to contribute to Taiwan's national priorities for upgrading technology and boosting exports. An example: It is insisting that the three suppliers of digital public switching equipment — AT&T, GTE and ITT — manufacture, or source, in Taiwan the same value as each of their switching contracts.

Accordingly, the general manager of GTE Communication Systems in Taiwan, Donald C. Blosser, says that GTE has invested $20 million to make its GTD-5 digital exchange in Taiwan and plans to use Taiwan as a base to export other products such as private branch exchanges (PBXs) and telephones to the Asian region.

"Taiwan has a lot going for it," Blosser contends. "Its government is efficient and has managed difficult situations very well. Labor quality is outstanding at all levels, at least on a par with our U.S. staff, and between a third and a quarter of U.S. salaries. There are no financial difficulties at all. We pay an effective interest rate on investment projects of only 6%." Blosser's enthusiasm is echoed by Ken Williams, president of RCA Taiwan, its biggest exporter. "It's a relatively easy place to do business," Williams says. "There's a good investment climate and stable politics."

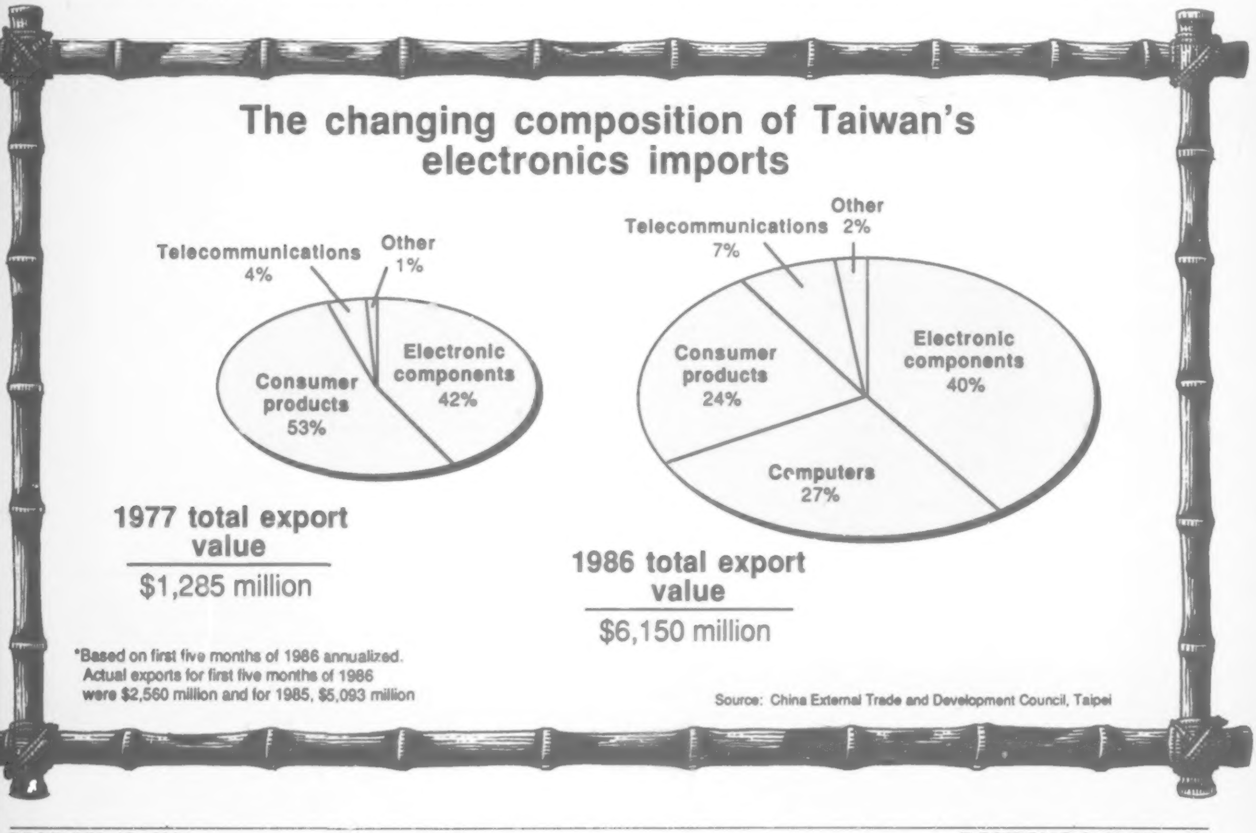
> Most of the foreign-owned plants in Taiwan are principally assembly operations

Sailing up-market

Certainly, Taiwan's first move up-market has been extremely successful. On the basis of its earlier manufacturing technology, learned in making low-cost televisions, it has established itself as a major producer of microcomputers, terminals, monitors and other computer peripherals. Although skeptics point out that most of these products do not possess any more high-technology than the products that preceded them, these products have given Taiwan a major stake in a rapidly growing market.

Taiwan's exports of computer-related products grew from just $114.6 million in 1981 to $1.2 billion in 1985 — including $300 million in monitors, $240 million in microcomputers, $225 million in terminals, $45 million in printers, and $42 million in disk drives. The China External Trade Development Authority predicts computer-related exports will continue to increase sharply and be worth $4.6 billion by 1989. This has already dramatically altered the mix of Taiwan's electronics exports.

This year the trend is continuing. The statistics for the first five months of 1986 show computer exports up 28%; telecommunications exports, 38%; and instrumentation exports, 42%, compared with the same period last year. However, those figures must



The changing composition of Taiwan's electronics imports

*Based on first five months of 1986 annualized. Actual exports for first five months of 1986 were $2,560 million and for 1985, $5,093 million

Source: China External Trade and Development Council, Taipei be tempered by exports of Taiwan's two traditional product strengths — consumer products and components each fell by around 2%.

Moreover there is one black cloud hanging over all the long-term hopes: the risk of protectionism in the United States, which accounts for almost 60% of Taiwan's electronics exports. Taiwan is now the second largest supplier of electronics goods to the United States. Last year, it exported $3.2 billion, behind Japan at over $20 billion, but ahead of Canada, Mexico, Singapore and South Korea which each exported around $2.5 billion, according to figures from the American Electronics Association.

And in overall economic terms, Taiwan's trade surplus with the United States is mushrooming. Last year it was about $10 billion; this year it could be nearer $15 billion, according to the Taiwanese government. Anxious about the growing threat of protectionism, the country's External Trade Development Council recently issued a lengthy report. It proposes that Taiwan mobilize its vast foreign-exchange reserves (expected to be $35 billion this year, which is almost as much as Japan's) to fund several major capital investment projects.

GI's Klein thinks that these big-ticket items — nuclear power plants, a subway system for Taipei, improved telecommunications and better production technology at factories — offer some interesting possibilities for U.S. and European capital electronics suppliers that do not compete with Taiwan's local industrialists. He hints that the government will try hard to soothe sentiments by favoring American contractors over competitors from Japan or Korea, but adds that this benefit will be small.

Adds Tatung's Wang: "Although we'd like to import more precision machinery and components, we need products that are appropriate to our needs. I think U.S. products often need minor changes to meet the demands of the Orient, and, of course, they must be competitive with products from Japan, Korea and Europe."

Most observers in Taiwan say that the country will succeed in making the transition into the fast-growing markets of the future. Concludes GI's Klein: "Taiwan will get into high-technology. It's going to be slow and on an individual company basis. [But] it will be permanent."

ANDREW TANK

Tank is an India-based journalist who travels extensively in Asia.

Consumer electronics: More to see and hear in 1987

Consumer electronics products continue to thrive although a stronger yen is squeezing Stateside dollar margins

For consumer electronics companies, the good news is that demand for most audio and video equipment is expected to continue to grow at a healthy rate through 1987 — with sales of popular items like compact disc players and big-screen projection televisions expected to soar. The bad news, however, is that price pressures are cutting back profit margins to a dangerous level. There has been "a chaotic erosion in the industry's prices," says Bob O'Neil, executive vice president of Hitachi Sales Corp. of America. "Few companies are making an adequate return on investment."

Making matters worse is the strength of the yen, worth about one-third more against the dollar than it was last year. Most consumer electronics products sold in the United States, of course, are imported from Japan. "We're caught in a dollar/yen squeeze," says Terry O'Flynn, senior vice president of Mitsubishi Electric Sales America Inc. and head of the company's audio/video group. Despite steady sales increases, O'Flynn says, "the bottom line will not look good because of the exchange rate."

Japanese companies are trying to counteract the double whammy of price cuts and the strengthening yen by building more equipment and buying more components in the United States. In September, for example, Mitsubishi opened its second U.S. color television facility. To start, the facility located near Atlanta will have a capacity of 20,000 televisions a month, but production will be expanded to meet demand, according to O'Flynn. Mitsubishi's other facility is in Santa Anna, Calif. Hitachi Consumer Products of America Inc. opened an assembly plant in Anaheim, Calif., in 1986.

Another countermeasure is creative marketing. Hitachi executives are per-

Three turn-ons in U.S. consumer electronics

Value ($ millions)	1985	1986	1987
Compact disk players	$217	$350	$425
Home VCRs	$4,735	$5,500	$5,900
Projection televisions	$488	$570	$610

Units (thousands)	1985	1986	1987
Compact disk players	966	1,800	2,500
Home VCRs	11,900	13,200	14,600
Projection televisions	266	320	350

Source: Electronic Industries Association

John McIntosh

sonally pushing their products across the country. In a 15-city road show — the theme of which is "Marketing for Survival" — Hitachi officials hope to teach some 2,000 retailers strategies for profitable merchandising. With profit margins so low, manufacturers argue, prices must be allowed to stabilize and volume must be increased to bring in more earnings. "Profitable volume is imperative if [product] innovation and merchandising are to remain strong and effective," says O'Neil. Hitachi also is promoting its

Despite squeezed profit margins, the picture has some bright spots. In 1986, for example, projection TV sales increased 20% to about 320,000 units from 266,000 units. To consumers, says O'Flynn of Mitsubishi, "bigger is better, because they are bringing the movie theater home." Bigger is also better for manufacturers, who generally have higher profit margins on these items.

Compact disc (CD) player shipments, meanwhile, increased to 1.8 million units in 1986 from a mere 35,000 units when CD players first hit the market in 1983, according to the Electronic Industries Association (EIA). In 1987, CD player sales are expected to climb to 2.5 million units.

With average unit factory prices dropping from $429 in 1983 to an estimated $170 in 1987, CD players have gone from being an expensive luxury for the elite to a major mass market item. Demand has exceeded industry expectations," says Allan Schlosser, EIA spokesman. Schlosser points out, however, that this "extraordinary growth" cannot be sustained for more than another year or two.

Growth of video cassette recorders (VCRs) also is expected to slow as market penetration increases. More than 40% of U.S. households reportedly now have VCRs, according to the U.S. Department of Commerce. And by 1992, the commerce department projects, two-thirds of all households will own video cassette recorders.

For now, though, VCRs are closing in on color TVs, a mature market that is holding relatively steady, as the cash cow for the consumer electronics industry.

Demand for audio products firmed in 1986 — with consumers interested in stereo systems as well as compact disc players. In traditional systems, buyers showed a decided preference for the convenience of complete stereo systems.

BETH KARLIN

Vision system vendors eye a board market

Printed circuit board builders are demanding automated inspection systems. An AOI multitude for multilayers

Question: What happens when 20 suppliers of bare printed circuit board (PCB) inspection systems spend over $100 million on product development in pursuit of a $50 million market? a) a vendor shakeout b) a smorgasbord for customers c) mass confusion. Answer: all of the above.

"We're in a classic immature market where everybody's trying to leapfrog everybody else technologically, and R&D [research and development] spending is way out of proportion to the size of the industry," says Paul Shirra, assembly and test product manager for Hughes Aircraft Co.'s Industrial Products Division. The division offers an automated optical inspection (AOI) system that uses laser imaging to inspect the artwork and inner layers of complex boards (up to 42 layers).

Reliable estimates peg the present worldwide installed base of these automated systems at only 200 to 225, representing about $50 million in capital spending. About 75% of the installed base, or 160 installations, belongs to one company, Optrotech Ltd., an Israel-based firm that pioneered AOI for bare boards three years ago. The second-leading supplier, with an estimated 20 to 30 installations, is another Israeli company, Orbot Systems Ltd. Other players with multiple system sales are said to include DIT-MCO International of Kansas City, Mo.; Hughes; and Visionetics Corp., a Connecticut start-up founded by former executives at Perkin-Elmer Corp. These, and an estimated 15 other suppliers, are scraping for orders in a 1986 market of no more than $30 million. Some optimistic analysts see pent-up demand for another 1,000 systems pushing the market to $60 million next year and $200 million by 1990, but a more prevalent view is that a shakeout is coming first, spurred by a parallel shakeout among merchant PCB vendors [ELECTRONIC BUSINESS Sept. 1, 1986 p92].

What is not in question, however, is the absolute necessity of AOI for probing outer and inner layers of sophisticated multilayer PCBs. Peter Bolda, the president of Basic Electronics Manufacturing Corp., a small merchant supplier of boards with up to 15 layers, says the company simply could

Tim Davis

OPTROTECH VICE PRESIDENT McDONALD says demand this year alone reached 600 systems in the automated optical inspection market

Drop continental manners, learn the local customs

U.S. firms regarding Europe as a single market will starve. Those seeing each country will feast

By Jack Gee

When Apple Computer Inc. launched its first drive into the European market, the company committed a series of strategic errors. The chief one was failing to recognize individual European countries as having separate markets, treating them instead as a homogeneous entity.

Apple paid a heavy price for failing to identify the differences between Europe's national markets for microcomputers. That ignorance prompted the company to make poor choices in almost every country where it selected local distributors. The exception was France where for years Apple's machines valiantly outsold IBM personal computers.

Michael Spindler, the current general manager of Apple's International Division, recalls: "We have done particularly well in France because we started out with an excellent French team who did a faultless job. We also had a very capable, visionary and outspoken general manager. Unfortunately, we did not have that situation elsewhere in Europe." The captain at Apple's helm in France was Jean-Louis Gassée, a Frenchman whose talents have since earned him an executive vice-presidency position at the Cupertino, Calif., headquarters where he is responsible for product development.

The core of the problem

Apple's early setbacks in Europe are far from the exception. Other U.S. electronics companies have bungled the job of devising strategies for a market with a population comparable to that of the United States but where, every few hundred miles, a national frontier with a formidable array of tariff barriers stands in the businessman's path.

NORWAY
SWEDEN
FINLAND
POLAND
FRANCE
SPAIN

> "Although the Europeans talk about their Common Market, a single market just does not exist"
>
> Robert Heikes of ES²

"Although the Europeans talk about their Common Market, a single market just does not exist," says Robert D. Heikes, who successively managed the European semiconductor operations of Motorola Inc. and National Semiconductor Corp. before becoming cochairman of European Silicon Structures. ES², located in the south of France, is the first company in Europe to design and prototype custom chips for the European market, which Heikes describes as "a terribly fragmented place in which to operate."

Others share Heikes' view. "The European market is really 14 different markets. There's one for each country, even for the tiny Duchy of Luxembourg," says Gordon Curran, associate director of Intelligent Electronics, a Paris-based market research firm. "But American electronics firms, particularly those in the office automation business, must not confuse smallness of scale with lack of maturity. And, although Europe as a whole is still not as big a user of microcomputers as the U.S., it is a highly sophisticated marketplace."

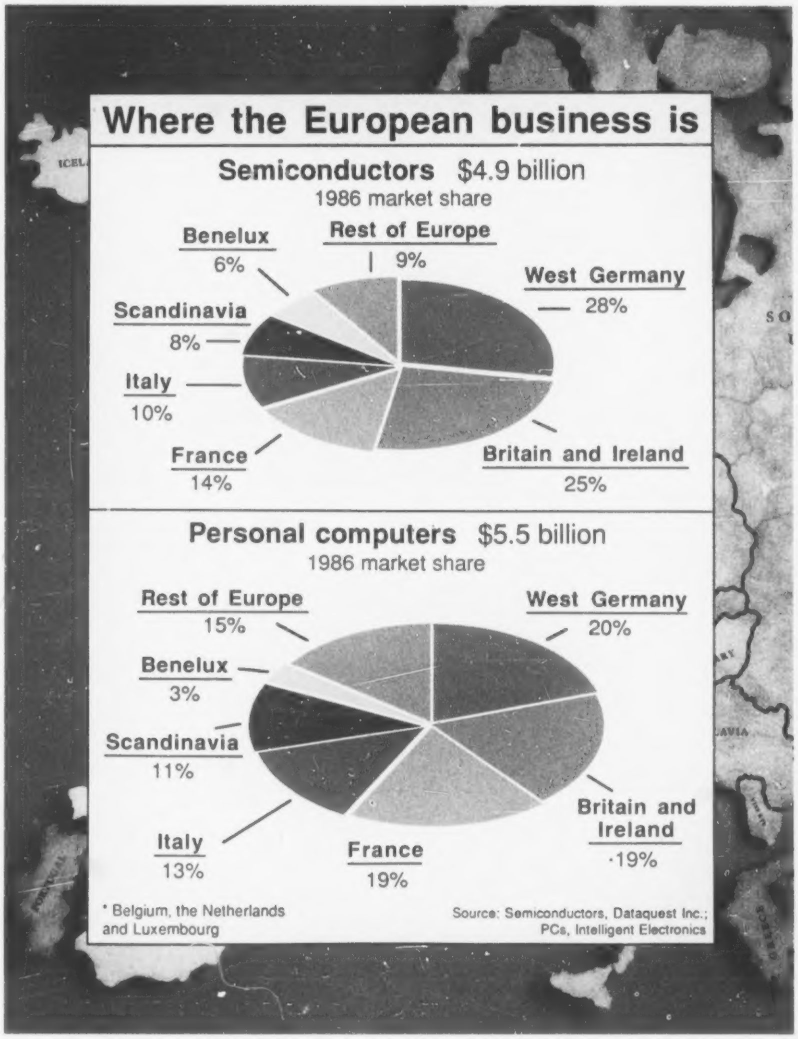
To U.S. newcomers that seek advice on how to make the plunge into the European market, Curran stresses that they cannot find a one-stop marketing solution. "You've got to have an Austrian managing your business in Austria and a German in Germany. Don't believe that a German can handle Austria simply because the people there speak the same language. Make sure you use local nationals in each country."

Technology counts

Curran also warns U.S. manufacturers that they cannot expect to make a dent in the European microcomputer market unless they offer unique products that challenge Apple, IBM and Italy's Ing. C. Olivetti & Co. (the No. 2 microcomputer seller in Europe). "The entry ticket is also becoming increasingly costly. Huge investment is necessary to set up market support and dealerships," Curran says. "And don't expect to sell a product in Europe if it has not succeeded in the U.S."

U.S. companies, as well as technology, face formidable competition. Klaus D. Kreuzer, senior director and manager of international marketing at Siemens' Data Systems Division, comments: "U.S. firms such as IBM are going to have an increasingly hard

Photograph/Dilip Chauhan



* Belgium, the Netherlands and Luxembourg

Source: Semiconductors, Dataquest Inc.; PCs, Intelligent Electronics

time in Europe as firms such as Siemens and Olivetti gather strength in the office automation business. The fight for market share is getting tougher for the Americans."

Aside from offering technological advice, market researcher Curran also counsels U.S. electronics companies against using Britain as a launching base for a European operation. "Of course there's a language advantage there for Americans," he agrees, and "flight time from the U.S. is also one hour shorter than to continental Europe. But Britain lies on the edge of the continental market, far from the main centers of penetration which lie in Germany and France."

"Don't believe you can use Britain as a soft option for stepping into mainland markets," echoes Roy Bright, a telecommunication consultant at Orpington, England. He cautions U.S. manufacturers not to pattern their sales strategy in continental Europe on their experience at home or even in Britain.

Learn the language

"It's very important to make sure that your brochures are adapted to local markets. A straight translation of the English-language original is not good enough, " Bright asserts. "And the glossy corporate documents favored by U.S. corporations cut no ice in Europe. Potential buyers of your product are not sensitive to hype. They want to know about its technical advantages."

IBM appears to have learned this lesson. Users of its personal computers in Europe often claim that the instructions from the local-language versions of its documentation are much easier to execute than those of the original English editions.

Bright spurred the marketing drive for Britain's Prestel videotex and then spent a five-year stint promoting French products worldwide for the government's Direction Générale des Télécommunications. He tells Americans not to underestimate the level of technology in France. "Whenever I go to the U.S. I remind people that France is no longer just champagne, fancy cheeses and high-class dresses," he says. "When marketing their own products, Americans must never forget that this is the country which converted its own population to videotex and introduced the microprocessor-memory credit card."

Most of the U.S. electronics companies that today perform successfully in Europe started out with local sales offices before embarking on full-scale manufacturing. "Before taking risks with a brand-new plant, a company must first test its product on the European market," suggests André Borrel, vice president for international semiconductor operations for Motorola, which followed such a course. Borrel, a Frenchman, headed Motorola's European semiconductor operations until earlier this year, when he moved to the company's worldwide semiconductor headquarters in Phoenix, Ariz.

"Semiconductors are global products," he explains. "You can sell them anywhere — in France, Britain, Germany — in the same way as in the United States — because a device's standards do not change from one country to another. The same applies to computers. A VAX from Digital Equipment Corp. is the same machine on both sides of the Atlantic."

But the same approach does not apply to all European electronics markets, however. With telecommunication equipment, defense products and consumer goods, U.S. manufacturers accustomed to selling a standard piece of merchandise back home will find themselves battling a maze of regulations and government-imposed standards differing from country to country. "This means that the newcomer from the U.S. usually has to spend a lot of money to develop his product to match each set of standards," Borrel remarks. "Very often, he'll decide it's not worthwhile."

European managers take over

A couple of decades ago, when many U.S. electronics companies were still newcomers to Europe, it was easy to find American managers and engineers in their companies' European plants and offices. Today this is the exception rather than the rule. All U.S. firms prefer to hire Europeans. "That way, they achieve better synergy between their own corporate requirements and the European environment," says Motorola's Borrel. "But it's important for companies,

IBM's BRIANT: "Our American colleagues learn a lot from working alongside Europeans"

such as ours, to send people to the States regularly for training and for U.S. managers and engineers to do stints in Europe."

IBM is a company where it is extremely unusual to meet an American on full-time assignment in Europe. As with Motorola, and many of its direct competitors, Big Blue also gives emphasis to a constant trans-Atlantic flow of personnel. Jean-Pierre Briant, vice president for manufacturing, systems and technology at IBM-Europe, says: "Our European plants profit from these exchanges. And our American colleagues also learn a lot from working alongside Europeans in the U.S. That's how IBM pushes up yields and improves quality. Thanks to this cross-fertilization, our European plants are ahead about half the time and the Americans the other half. In this way, we avoid complacency."

IBM is not alone in recognizing the quality of Europe's managers and engineers. These professionals are earning increasing respect in the United States. "No U.S company can afford to underrate Europeans," says Marco Landi, European semiconductor marketing director for Texas Instruments Inc. "And very few do."

The TI executive considers this new respect paid to European managers as the outcome of a radical change in Europe's attitude toward the electronics industry. "The European semiconductor companies are moving out of their local arena and targeting world markets," Landi explains. "And to do this they are doing what the Americans did years ago. They, too, are crossing the Atlantic."

N.V. Philips of the Netherlands took the lead in 1975 when it acquired Signetics Corp. in order to establish a U.S. presence. Germany's Siemens followed suit when it bought a 15% stake in Advanced Micro Devices Inc. France's Thomson SA continued the trend, buying most of Mostek Corp.'s assets last year from United Technologies Corp. And SGS of Italy has built a state-of-the-art wafer fab in Phoenix, but it is postponing completion until signs of a market revival for the semiconductor industry emerge.

"All these European firms have something to offer the U.S in exchange for American technology," TI's Landi remarks. "It's a two-way street. In our company we have confirmed our confidence in European technology by our recent alliance with Philips to develop advanced CMOS [complementary metal-oxide semiconductor] logic devices together."

"The U.S. firms have always done a good job in Europe," says Jacques Noëls, chairman and managing director of Thomson Composants, the electronic components division of the state-owned French group, and former president of Texas Instruments-

Choosing a business location in Europe

It is essential for U.S. electronics manufacturers to look at each of Europe's fragmented marketplaces from close at hand. "You've got to get the dirt under your fingernails and create the personal interface in each country," says Gordon Curran, associate director of Intelligent Electronics, a Paris-based market research firm. "You can't depend on reports and statistics and what other people tell you."

U.S. companies intending to build plants or establish marketing networks in Europe should not focus on countries that offer the most generous fiscal advantages, Curran advises. They should choose a site that has the best possible market penetration for their products. The market researcher adds, "In order to sustain your high investment and operational costs, it's wiser to set up your business in a country with a big national market."

The Netherlands probably has the most attractive banking environment. But the local market is small. The French invented the word "bureaucracy" — and are the best practitioners of it in Europe. But, in spite of all that red tape, U.S. firms such as Fairchild Semiconductor Corp., Intel Corp. and Texas Instruments have all discovered compelling business arguments for establishing their European headquarters in France.

Curran himself was drawn to France five years ago when he and his wife, Brigitte Morel, set up their market research firm. "Paris was clearly the best place from which to monitor Europe," says Curran, a Scottish engineer.

"But we can't just sit behind our desk on the River Seine's Left Bank and discover what's going on in the other thirteen national European electronics markets outside France," declares Morel, a former marketing manager for a big U.S. cigarette company. "It means visiting each of them at least twice a year." ☐

France. "Now the Europeans have learned the lessons taught by their American mentors and are targeting world markets. And we're achieving our objectives with smaller resources. Too often, the U.S. firms indulge in overkill to arrive at the same results."

Japanese up the ante

Increasingly, U.S. companies are discovering that their comfortable European market shares are being nibbled away at by Japanese rivals. "Japan is putting a lot of design resources into Europe," observes Peter Savage, associate director for the European Semiconductor Division of Dataquest Inc., the San Jose, Calif., market research firm. "They will double their sales here over the next year or so," says Savage.

NEC Corp. has installed a wafer plant in Livingston, Scotland, and Hitachi Ltd. has also established one in Landshut, West Germany. Savage warns: "The Japanese are now putting down a serious challenge to European and U.S. manufacturers with design resources that target Europe's growing market for application-specific integrated circuits."

The Japanese are also mounting an assault on another U.S. bulwark in Europe, the semiconductor equipment-manufacturing industry. Philippe Geyres, director of Thomson SA's bipolar division, who recently set up a new plant for his company at Maxeville in eastern France, ordered 80% of its equipment from Japan. "We bought only the computers and tester from the U.S.," he reports.

Geyres congratulates Oki and other Japanese firms for the skill and energy they used to win and execute the Thomson contracts. He says: "The Japanese still have a problem in providing after-sales service in Europe. American firms, such as Teradyne and Perkin-Elmer, are so long-established here. But many U.S. manufacturers are resting on their laurels in Europe."

Geyres' boss, Noëls, is also keenly aware of the advances Japanese equipment suppliers are making in Europe at the expense of their U.S. competitors. "The Americans remain very strong on innovation," says the chief of Thomson's semiconductor operations. "But, by optimizing the use of semiconductor equipment, and in test machines, the Japanese are grabbing markets in Europe."

MOTOROLA's BORREL: "Before taking risks with a brand-new plant, a company must first test its product on the European market"

Managers of electronic companies differ in their views on the ease of operating in Europe. Some find it more stimulating than working in the United States. Others say that Europe still lags in engineering and marketing skills.

The semiconductor environment in the United States is far more conducive to business than in Europe, argues Daniel Queyssac, president of SGS USA, a subsidiary of Italy's SGS. "The rules are clearer here," says this Frenchman, who hopes to become an American citizen soon. "In the U.S., performance is the key criterion. Europe is entwined in too much politics, national product specifications and rules — either spelled out or unwritten — that restrict opportunities for suppliers."

Changes ahead in the European semiconductor market

	1986	1991
Integrated circuits	75%	86%
Discrete devices	20%	10%
Opto-electronic devices	5%	4%
Total market ($ billions)	$4.9	$12

Source: Dataquest Inc.

Queyssac adds: "In Europe business relationships are too cozy, and people are too tolerant of mistakes. In the U.S., if you drop the ball, you don't get any support. And that's the way it ought to be."

Heikes, the Motorola and National Semiconductor veteran, disagrees. "I don't detect all that difference between doing business in the U.S. and Europe," he says. "In fact, in many ways it's easier for a semiconductor manager to run his business here than in the U.S."

Although a top manager at a U.S. subsidiary in Europe might find himself dealing with a lot of customers smaller in size than he would find in the United States, he exercises more responsibility and authority than he would back home. "The distance between himself and his U.S. headquarters allows him more scope for initiative than a person in an equivalent stateside job," Heikes maintains. "He also has an advantage over European managers at his own level because their corporate bosses are probably sitting in the next room, reviewing the accounts day by day. In Europe, he's not working in a strange new world. His competitors are the same big U.S. semiconductor companies against whom he has always been contending."

U.S. managers in Europe are often

THOMSON's NOËLS: "Europeans have learned the lessons taught by their American mentors and are targeting world markets"

more motivated than their European counterparts, Noëls agrees. "But now we at Thomson are learning how to run a hands-off, long-distance operation following our acquisition of Mostek," he says.

Heikes discounts the strength of the challenge from the European semiconductor companies and is dubious about whether Thomson's purchase of Mostek assets will finally pay off. He says: "During my many years in Europe I've seldom lost an order to any European semiconductor manufacturer. I would not even agree that national loyalties operate in their favor. It's always price that determines the outcome."

The toughest nut to crack

In telecommunications, however, U.S. firms find themselves handicapped against their European rivals. In seeking to sell their switching systems, manufacturers must obtain approval from regulatory bodies in each country. "Getting approval for his product in one country may delude an American vendor into believing he can go ahead and sell it all over Europe," says consultant Bright. "But he has to go through the process in each country. It's not a once and for all arrangement like in the U.S."

Even in Britain, the only country in Europe where telecommunication carriers have been deregulated, this protracted process still presents a hurdle. British Telecom recently recruited more staff to speed up the approval procedure, covering modems, private branch exchanges (PBX) and big switches, which currently takes between three and six months.

France is particularly inhospitable to foreign equipment. To protect its own modem manufacturers the country has approved only a handful of U.S. modems for use on its growing data network, which is totally controlled by the government-managed Direction Générale des Télécommunications.

Support, either blatant or discreet, for national companies by European governments and their agencies acts

Washington isn't helping

It is not just European trade barriers and strategic errors by U.S. electronics companies that are handicapping U.S. business in Europe. President Reagan's controls on high-technology exports also have proved a hindrance.

A survey conducted recently by U.S. government officials in West Germany reveals that European customers of electronic components and equipment are complaining that curbs imposed by the White House delay shipments. According to the survey this occurs so much that the customers are turning to other suppliers, either from Europe or, more increasingly, from Japan.

The survey, organized by the commercial section of the U.S. Embassy in Frankfurt, West Germany, indicates that the Reagan controls are spurring several companies — either German-owned or U.S. subsidiaries — to redesign their products. The objective is to incorporate fewer U.S. parts and, instead, use more readily available European or Japanese components.

One German distributor of electronic components estimates that it is switching 25% of its component orders away from U.S. suppliers and toward Japanese firms in order to meet the requirements of local manufacturers.

U.S. companies in Germany also are complaining that compliance with the Reagan restrictions is boosting their administrative overhead. For big companies this cost has risen as much as 25%.

The firms questioned in the survey indicate that they are determined to change from U.S. suppliers unless the White House behaves more flexibly about exporting U.S. technology.

For some years now, U.S. allies have been complaining that Washington has been restricting sales of high-tech equipment to the western area in order to prevent such equipment from being reshipped to the Soviet Union and other Communist states in Western Europe.

At an East-West trade fair in Leipzig, East Germany, Getac Instrumenbau, a small West German company, put up a sign in its booth that proclaimed: "American embargo regulations do not permit our systems to be exhibited."

Hans J. Fiedler, Getac's sales manager, claimed that his company's shipments of U.S.-made instruments to Eastern Europe had been crippled by tightening American restrictions on high-tech exports. "But the cowboys are prospering," Fiedler grumbled, referring to underground salesmen. "They're prepared to deliver whatever the Communists want — at a price." ☐

as a powerful deterrent to foreign suppliers. Substantial chunks of the public switching business — usually up to 50% of the market — are guaranteed to Siemens by West Germany's Bundespost, to Philips by the Netherlands telephone authority, and to Italtel by Italy's SIP. "These market shares are not necessarily written down. That does not matter because they are rigorously applied," says Bright.

Weighing the advantages and disadvantages of doing business in Europe is not an easy task for a company that is hesitating to make the leap across the Atlantic. It is certainly easier for the long-established companies, such as IBM whose European presence nearly dates back as far as its founding, than it is for those that are disembarking today. But European governments, concerned about high levels of unemployment, welcome investment from these newcomers. Some are even trying to unravel the red tape which so often discourages U.S. entrepreneurs.

Praise for U.S. quality

What matters more, perhaps, is that the United States' European customers in electronics continue to applaud the quality of service that they are getting. Pierre Alex, president of France's component distributors body, Syndicat Professionel de Distributeurs Electroniques Industriels, says: "The Americans never let us down. However, the European manufacturers are now offering new, interesting chips. This reflects the new vigor which has been infused into our own semiconductor industry."

Some European culture has been infused into U.S. companies as well. "The American suppliers have learned a lot in Europe during the past 20 years," says Gerard Pasturel, president of the French semiconductor components manufacturers' professional federation, Syndicat des Industries des Composants Electroniques et Semiconducteurs. "In the old days they often stamped around in big Texan boots. Now their mentality has changed. They're more chameleonlike and use many more Europeans to run their operations here."

Whether they uncork a bottle of French champagne, British beer or German schnapps, the U.S. electronics industry's managers in Europe would certainly raise their glasses to that tribute. ☐

DEC focuses products on its fastest growing market

Digital Equipment Corp.'s European sales rose 16% to $2.2 billion in 1986. More of the same is expected in 1987

When Digital Equipment Corp. recently spent $5 million to invite 15,000 of its European clients to DECville, a lavish two-week, company-sponsored trade show on the French Riviera, it had something more original to propose than computers which had already been launched in the United States. Targeting its fastest growing market, DEC set out to demonstrate that it is now crafting products specially for its customer base in Europe.

DEC is putting up a particularly encouraging performance on that continent where sales in the fiscal year that ended last June rose 16% to more than $2.2 billion from the same period a year earlier. That compares with the company's worldwide growth of 14% on sales of $7.6 billion. DEC, which is headquartered at Maynard, Mass., keeps a workforce of 21,000 busy in Europe out of its 95,000 employees around the globe.

"We can expect our sales and earnings in Europe to grow even faster in the current fiscal year," predicts Pier-Carlo Falotti, president of Digital's European operations. Analysts say this factor will be a crucial one in helping the manufacturer to compensate for the continuing lack of buoyancy in the U.S. market. DEC's sanguine European outlook sharply contrasts IBM's view.

Kenneth Olsen, DEC's president and founder, who flew over to open the Riviera extravaganza in Cannes, shares Falotti's confidence. He says DEC will continue to "do well" in the United States. But he stresses that the U.S. computer industry will have to continue wrestling with a slump for some months ahead.

Designs on special markets

Among the VAXmates and other recent stateside DEC designs on show at DECville was a videotex terminal developed in France for which the manufacturer forecasts a glowing European future — but perhaps no market to speak of in the United States, at least for a moderate period of time.

The terminal has been conceived

DEC's EUROPEAN CHIEF FALOTTI: "We can expect our sales and earnings in Europe to grow even faster in the current fiscal year"

Influential accents: Foreign firms gain in U.S. markets

Foreign companies are continuing to expand their presence in the U.S. market. Ten foreign firms have a billion dollar impact

By Fred McGrail and Linda Stallmann

The competition in U.S. markets from foreign electronics companies is evident at a glance at those companies' electronics sales figures. Based on U.S. sales, the top 10 foreign companies would all rank among the top 50 of the ELECTRONIC BUSINESS 200, the magazine's annual ranking of the leading U.S. electronics firms. The leading foreign company, Japan's Matsushita Electric Industrial Company Ltd., would rank ninth, between Hewlett-Packard Co. and Motorola Corp., with U.S. electronics sales of $6.52 billion.

All 10 of those companies, six of which are Japanese, each sold more than $1 billion worth of electronics in the United States. Another three companies were close to the billion-dollar figure, topping $900 million in U.S. sales.

But if foreign companies are selling more in the United States, they are also building more plants here and employing U.S. workers. Kathleen Molony, a senior analyst with Data Resources Inc. in Lexington, Mass., sees several factors that lead her to believe that trend will continue. Part of the reason that Japanese firms, for instance, have in the past located some plants in the United States was to ease trade tensions, Molony says. But the recent rise in the yen has also made moving operations to the United States more economically feasible. NEC Corp., for instance, has five major plants in the United States employing 5,000 workers, manufacturing everything from telecommunications gear to semiconductors, and plans to open more.

The movement of manufacturing operations outside Japan is similar to what U.S. companies did during the 1970s, says Daniel Hefler, director of global sourcing with the Arthur D. Little Co. The large decline in the value of the yen caught both the Japanese and the Americans by surprise, he says, and has hurt Japanese electronics firms.

"The Japanese will do whatever it takes to maintain [U.S.] market share. Market share is of paramount importance." Meanwhile, though, Japanese companies are absorbing some losses in electronics, he says. "They're taking it on the chin, but they're willing to take the losses because they don't think it [the devalued yen] will be forever."

> Ten companies, six of which are Japanese, each sold more than $1 billion worth of electronics in the United States

"The trend toward establishing foreign manufacturing facilities has some Japanese worried," says Molony. "There is a greater push to sell and produce more in the U.S.," she says, and that has raised concerns about the impact on the Japanese employment picture. "Some people in Japan are becoming concerned," Molony says, "particularly about the impact on less skilled Japanese workers." While there is a benefit to the United States in terms of jobs, the revenue from such enterprises will still go to the Japanese companies, Hefler points out.

In addition to the Japanese moving operations offshore, Molony also anticipates more joint ventures between foreign and U.S. companies. "I think we'll see more tie-ups between Japanese and American firms," she says. One such agreement, between Honeywell Inc. and NEC, has quickly drawn cries of protest. The Air Force awarded a $33 million contract to Honeywell for a computer system which will be used to schedule flights and provide weather information.

The computer was designed by NEC, and utilizes NEC central processors and chips, while Honeywell provides software and peripherals. Control Data Corp., which lost in the bidding for the system, alleged that NEC used the Honeywell connection to gain entry to the U.S. government armed services market, which has been the sole province of U.S. companies. Control Data Corp. also charged that the price suggests NEC is dumping products into U.S. markets. NEC denies both allegations.

Whatever the final determination, the tie between NEC and Honeywell is a clear example of one Japanese company's aggressive attempt to move into a new U.S. market. Having gained dominance in the area of consumer electronics, but now facing a real threat from Korean companies, foreign companies, particularly the Japanese, are looking to new horizons. "The Japanese have targeted electronics," Molony says, "and they clearly want dominance."

But while Japanese companies dominate the top 10, European firms are also well represented on the ELECTRONIC BUSINESS list, with both West Germany's Siemens and the Netherlands' N. V. Philips' GL in the top echelon, joining Canada's Northern Telecom Ltd. The United States represents the most lucrative market in the world, so it is hardly surprising that foreign companies are tapping it. "It [the U.S. market] is no longer ours," says A.D. Little's Hefler. □

Top foreign companies in the United States

Company	U.S. electronics sales ($ millions)	Total consolidated sales ($ millions)	Profit before taxes ($ millions)	Fiscal year ended	Country of origin
Matsushita	$6,520	$24,890	$3,396	11/85	Japan
Philips	3,430	18,140	525	12/85	Netherlands
Northern Telecom	2,870	4,252	434	12/85	Canada
Sony	2,250	6,702	669	10/85	Japan
Sharp	1,460	N/A	N/A	3/86	Japan
NEC	1,450	13,116	662	3/86	Japan
Siemens	1,340	20,425	1,423	9/85	West Germany
Toshiba	1,310	18,739	725	3/86	Japan
Sanyo	1,200	5,163	N/A	11/85	Japan
Canon	1,090	4,779	444	12/85	Japan
Mitsubishi	1,000	8,139	397	3/85	Japan
GEC	980	7,735	1,032	3/86	Britain
JVC	950	2,978	209	3/85	Japan
Schlumberger	900	6,557	617	12/85	Netherlands
Hitachi	720	29,473	2,183	3/86	Japan
Fujitsu	650	9,399	283	3/86	Japan
Olivetti	620	3,684	323	12/85	Italy
Samsung Electronics	550	N/A	N/A	12/85	Korea
C. Itoh	500	88,528	141	3/86	Japan
Kyocera	485	1,568	241	3/86	Japan
Racal	470	1,865	133	3/86	Britain
TDK	430	2,124	351	11/85	Japan
Thorn EMI	430	4,884	154	3/86	Britain
Oki Electric	400	2,181	12	3/86	Japan
Lex Services	390	1,507	34	12/85	Britain
Pioneer Electronic	390	1,572	21	9/85	Japan
Commodore	360	889	-128	6/86	Bahamas
CGE	320	10,390	221	12/85	France
Ericsson, LM	310	4,281	165	12/85	Sweden
Thomson	300	7,831	97	12/85	France
Plessey	260	2,152	251	3/86	Britain
Alps	240	2,003	111	3/86	Japan
Mitel	130	302	-65	3/86	Canada
Nixdorf	130	1,604	123	12/85	West Germany
Mannesmann	120	7,425	334	12/85	West Germany
Smith Industries	120	525	65	7/85	Britain
Canadian Marconi	110	166	27	3/86	Canada
AEG-Telefunken	100	4,900	N/A	12/85	West Germany
Advantest	80	371	84	3/86	Japan
SGS	70	306	-20	12/85	Italy

Source: ELECTRONIC BUSINESS

DSPs: Clear signals for a rising market

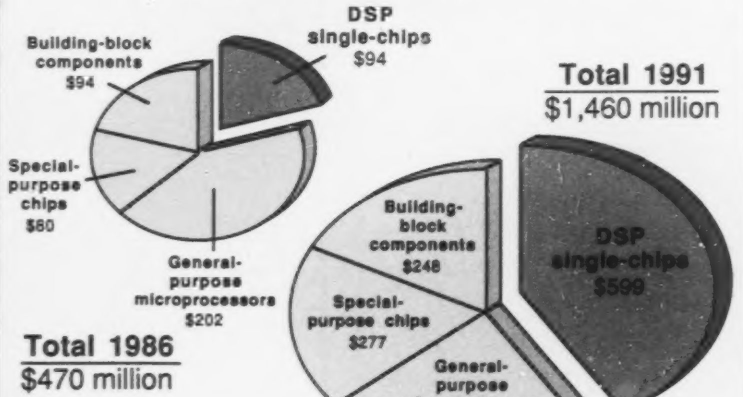
Digital signal processing, once restrained by technology and high prices, is now on the monolithic move

By Carol Suby

Although digital signal processing — digital processing of analog signals — has been around for more than a decade, its progress as a viable component market has been snail-paced. Before 1980, the digital signal processor (DSP) market was restrained by a lack of technology and high price tags. However, recent progress in the development of very large scale integration (VLSI) semiconductor circuits, advances in complementary metal oxide semiconductor (CMOS) technology and the creation of more elegant architectures have all contributed to drive DSP use beyond the high-end military arena to include the commercial market, where potential uses are myriad and hold the promise of volume sales.

DSP single-chips take the market by storm

Worldwide digital signal processor shipments ($ millions)



Source: Electronic Trend Publications

THE MARKET

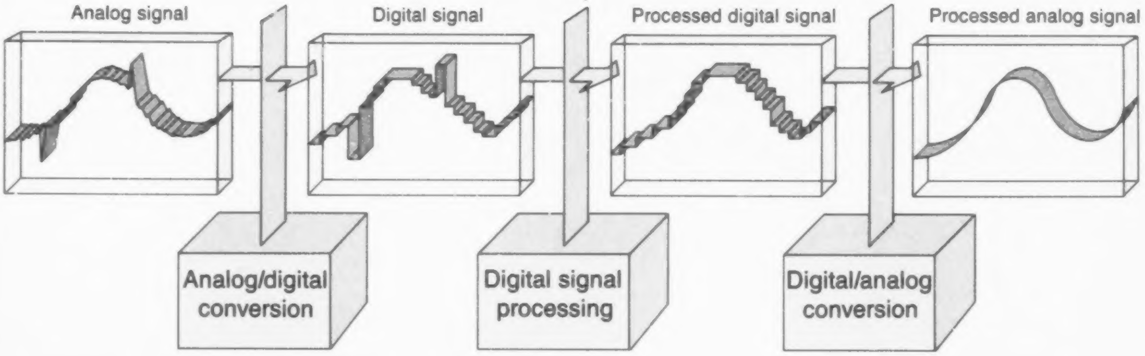
Today, semiconductor manufacturers are looking to DSPs as a golden opportunity to boost sluggish bottom lines. The numbers are impressive, holding at least as much promise as that of the microprocessor market when they were first introduced. The worldwide DSP and DSP-related integrated circuit market — including both conversion and signal processing components — is estimated to be worth $470 million for 1986, according to a report published by Electronic Trend Publications (ETP) in Saratoga, Calif. This number is forecast to reach $1.46 billion by 1991.

Calling 1986 "the year of the DSP," William Strauss, president of research firm Forward Concepts in Tempe, Ariz., points out that there have been more DSP product announcements in 1986 than in the entire history of DSPs. Strauss expects the DSP and DSP-related integrated circuit market to be worth more than $6 billion by the end of 1993.

The commercial DSP history began when Japan's NEC Corp., and Dallas-based Texas Instruments Inc. were able to produce successful single-chip, general-purpose DSPs in the early 1980s. "Getting a DSP solution in a single chip [is] what finally caused the market to explode," says John Rizzo, marketing vice president at Weitek Corp. in Sunnyvale, Calif. These programmable single-chip DSPs were easier to incorporate into systems and were also far less expensive than the building-block approach to signal processing. The use of multiple components for signal processing had been around for some time but was expensive and applications were limited almost entirely to the military.

At the low end of the DSP market, components handle applications within the audio range, at frequencies of 25 kilohertz (KHz) and below. Midrange is considered to be between 25 KHz and 500 KHz, where video and telecommunication multiplexing functions are performed. The high end, which includes radar, radio and television type applications, is found at frequencies as high as 100 megahertz (MHz). Anything beyond that is either for military or experimental applications, says Strauss of Forward Concepts.

What single-chip end users gain in


Analog signal
Digital signal
Processed digital signal
Processed analog signal
Analog/digital conversion
Digital signal processing
Digital/analog conversion

Working in real time

In digital signal processing, speed is the Holy Grail. In order to process real world information in real time (precisely as events occur), computers have to work at extremely fast speeds. The world functions in analog form, while our computers work digitally. A digital signal processor (DSP) takes analog signals — such as a voice or a moving target — converts them into a digital stream of bits and bytes, manipulates those signals and then reconverts the data back to analog form. Because of hardware limitations, components often could not manipulate data fast enough to keep up with the pace of signalling.

And so, although digital signal processing has been around for decades, its use in practical commercial applications has been held back. Historically, DSP components were either too slow or, if fast enough, too expensive to be applicable for most commercial uses. As a result, they were limited to military use — such as radar and sonar signal processing — where processing information in real time is of ultimate importance and price is inconsequential.

"Electronic warfare has essentially been the chief driver of DSP for years," says Willaim Groves, vice president technology at In-Stat Inc. in Scottsdale, Ariz. Indeed, fallout from the Department of Defense's (DoD) 10-year, billion dollar Very High Speed Integrated Circuit (VHSIC) program — which is spawning increasingly complex and compact chips — is already filtering down to the commercial marketplace and allowing semiconductor manufacturers more tools and technology to build more practical DSPs.

Over the last several years, Honeywell Inc. has received $80 million in contracts from the DoD under the VHSIC program and has invested nearly the same amount of its own funds to develop 1.25 and sub-micron-based chips, which, according to Pat Narendra, director of DSP products at Honeywell's Signal Processing Technologies Division, in Colorado Springs, Colo., has given them "a leg up" in the commercial marketplace. Here Honeywell is focusing on high-end, application specific DSPs produced in CMOS using 1.25-micron technology. According to Narendra, these two features "give you the performance you look for to make DSPs in affordable prices. It allows you to put four to eight multipliers operating at 25 nanoseconds each on one chip, doing the equivalent of 16 to 20 LSI chips at two to three times the speed."

> In order to process real world information in real time, computers have to work at extremely fast speeds

In fact, the progression in integrated circuit processing technologies — from bipolar, to negative-channel metal-oxide semiconductor (NMOS), to complementary metal-oxide semiconductor (CMOS) — has made it possible for manufacturers to produce DSPs that consume less power. And, although CMOS was originally slower than bipolar, it is now approaching the lower limits of top bipolar performance and more improvements are on the horizon. "The upper levels of CMOS performance have not yet been reached," says Maryann Bader, president of research firm Bader Associates, Mountain View, Calif.

In addition to changes in hardware, a shift toward more elegant architectures has also increased DSP speeds. In the pre-1980s, the von Neumann architecture, which was used in most general microprocessors, had shortcomings that slowed data flow. The Harvard architecture — which allows for the independent operations of data and address paths, thus increasing processing speed — is growing in popularity and is used in almost all general-purpose, single-chip DSPs today.

The evolutionary process of new architectures is continuing, Bader points out, and other major architectures include: parallel processors, which spread the computational burden over several devices; systolic processors, which is an extension of the parallel processor scheme, but is more powerful; and data flow architecture, which contains several processors, each able to perform different instructions. Although the data flow architecture offers enormous computational capability, it has not yet evolved to the point where it can be economically utilized. However, Bader suggests, "When it can be integrated on a single chip . . . it could well become the preferred architecture of the future." ☐

WEITEK's JOHN RIZZO: "Getting a DSP solution in a single chip [is] what finally caused the market to explode"

Tim Davis

cost savings, however, they sacrifice in performance. As a result, initial industry assumptions that single-chip DSPs would eventually replace the building-block components have faltered. Although there may be some grey areas where both product types might compete, the smaller, more economical single-chips are mainly being used in new applications while building-block components will continue to find safe havens in niche applications.

Although applications for building blocks will also grow, they will not be in mass markets, says Maryann Bader, president of Bader Associates and author of the ETP report. On the other hand, Bader adds, the possibilities for single-chip components are at the tip of the iceberg. "We've not even begun to scratch the surface of where they're going to put those babies," she says. General-purpose single-chips are expected to grow from 20% of today's DSP market to 41%, or about $600 million, by 1991. Building-blocks will decrease a bit from 20% to 17% during that same time frame.

Another DSP product type includes general-purpose microprocessors that are used in DSP applications. These components currently account for the largest segment of the market with a 43% share. The most popular general-purpose microprocessor used for digital signal processing, according to Strauss, has been the Motorola 68000 family, followed by Intel's family of microprocessors. Although microprocessors are easily programmable, they often lack the speed of chips designed specifically for signal processing. As more alternatives become available to end users, Bader predicts that these components will decrease in use and in market share, shrinking to 23% by the end of 1991.

The fourth product group includes special-purpose DSPs — components that are either dedicated chips (designed to operate in a specific device such as a modem) or special function chips (designed to perform a specific operation such as filtering). Although Bader does not expect special purpose DSPs to gain much in market share between now and 1991, she does expect their value to increase from $80 million to $277 million.

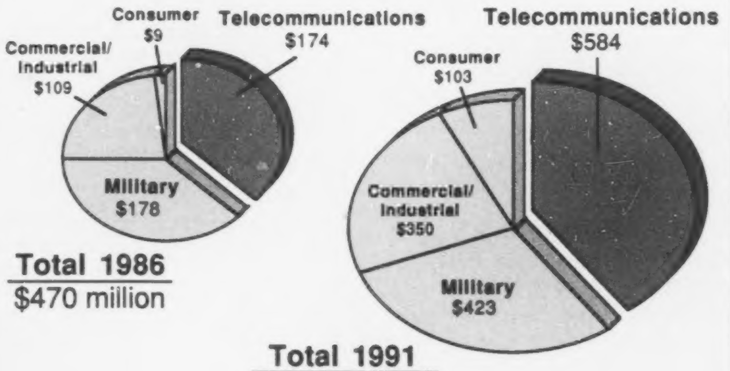
In the commercial applications arena, telecommunications is, and will remain, the stellar market. Today, Bader estimates that this segment represents $174 million, or 37% of the market. This share will increase to 40% by 1991 and grow in value to $584 million. According to Strauss of Forward Concepts, who authored a DSP report published by Gnostic Concepts Inc., by the year 1993 DSPs for telecommunications will be valued at $1.67 billion.

Sitting in the telecom DSP driver's seat, Strauss suggests, will be the implementation of a worldwide integrated services digital network (ISDN), which will require a tremendous amount of digital signal processing. For example, Codecs — a DSP chip that converts analog signals into digital bit streams and vice versa — will be incorporated into every telephone hooked into the ISDN network. Sales for this single type of DSP could be "astronomical," accounting for billions of dollars in sales over a 20-year period, ventures Strauss.

Indeed, the potential volume in telecommunications DSPs is "so huge," notes Stephen Campbell, product marketing manager for microcontroller products at Advanced Micro Devices Inc.'s (AMD) San Antonio, Texas facility, that the company has a marketing group and a design staff

Telecommunications – The stellar application for DSPs

Worldwide shipments of DSPs by major market segment ($ millions)



Source: Electronic Trend Publications

dedicated to the development and selling of chips tailored specifically to telecommunications applications.

The military applications segment, which currently represents the largest DSP market at $178 million or 38% of the 1986 market, will lose some market share as commercial applications proliferate. However, while decreasing to a 29% share of the market, its value is expected to grow to $423 million by 1991, Bader expects. Building-blocks are the most frequently used type of DSP in the military, but general-purpose single-chip DSPs are wending their way into military use as well.

Although both military and telecommunications applications will dominate DSP use long into the future, there are several other "hot" possibilites for the coming years. The use of DSPs for speech synthesis has been around for a long time, yet Strauss of Forward Concepts believes that "even greater growth [for DSP applications] will be in speech recognition." This application, he adds, is of great interest to Japanese companies, which are heavily investing in this area today.

Graphics applications — where signal processing chips are used in graphics displays and engineering workstations — will be "a biggie," says Strauss, who expects graphics to push DSP sales for computer applications from $42 million in 1986 to an estimated $1 billion by 1993. Other applications that present growth potential include: high-speed computing — where DSPs make it possible to process data at speeds of five million instructions per second (MIPS) or 20 million floating point operations per second (MFLOPS); industrial controls — where DSPs can improve both robot controls and computer-aided manufacturing; and image processing — where medical applications such as CAT scanning and ultrasound are made possible and improved.

THE COMPETITION

If DSPs become as pervasive as promised, getting involved in early design-ins can be important to future success. In the general-purpose, single-chip DSP market, two manufacturers have racked up a 93% share of this $94 million market, according to the ETP report. (Texas Instruments has 68%, and NEC has 25%.) Competition, however, is heating up. Approximately 18 new entrants — including Analog Devices Inc., Matsushita Electronics and National Semiconductor Corp. — announced products this year. Although the TI/NEC domination is expected to continue through 1991, both are expected to lose some shares to the new and existing entrants.

"The lower frequency areas are saturated," says Pat Narendra, director of DSP products at Honeywell's Signal Processing Technology Division in Colorado Springs, Colo. "You really have to look at the high-frequency DSP [one megahertz and higher] in order to penetrate the market." Nonetheless, the low end promises volumes in orders of magnitude greater than those expected for more specific, high-end components. Then again, low end does not command the higher average selling prices of the high-end products.

Getting involved in early design-ins can be important to future success

"At the high end [of the market], where performance is the overriding determining factor, [you] don't sell $25 to $30 chips," says Weitek's Rizzo. Its 3332 floating point DSP component sells for $450, or about ten times the cost of a Texas Instruments' TMS 320 DSP, and offers 20 to 30 times the performance level, Rizzo says.

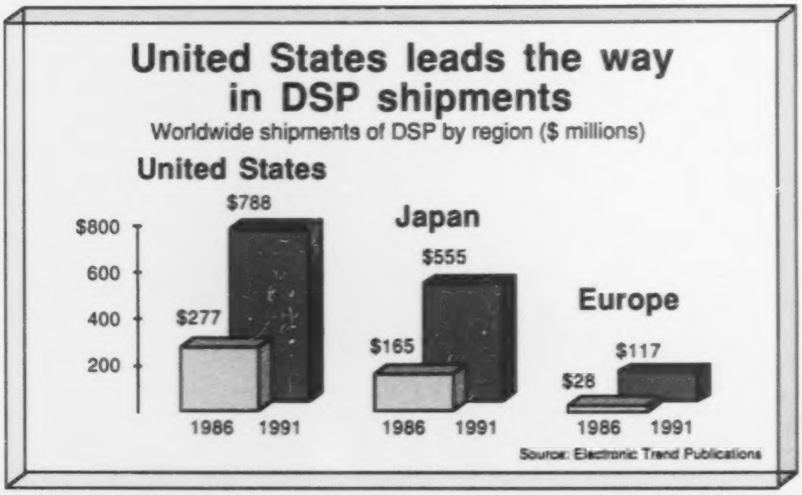
Weitek was incorporated in 1981, placing it in the start-up category. Being new on the block means finding niches where the chances of being trampled by the leading semiconductor behemoths are nonexistent. In fact, according to Rizzo, "my job is to continue to make our niches small." By being more specialized, he adds, the company is "better protected. There's not 500 people in our areas."

Leaders in the building-block DSP market include: Analog Devices with 20% market share; Integrated Device Technologies in Santa Clara, Calif. with 20%; Weitek with 20%; TRW with 17%; and AMD with 13%, according to the ETP report. Some traditional building-block manufacturers — including Analog Devices — are also extending their product lines to include single-chip DSPs.

It is not surprising to find a number of companies with strong military ties entering the DSP market. Equally unsurprising is the fact that most of them are addressing high-end areas with building-block and application-specific solutions.

Even within the military, DSP applications are varied. Lexington, Massachusetts-based Raytheon Co. is manufacturing building-block DSPs primarily for integration into a number defense systems also built by Raytheon. "Commercial users don't require the bandwidth or sophisticated algorithms used in military applications," notes Rudolf Thun, Raytheon's director of device technology. The degree of precision required in a radar system that must recognize approaching enemy jets is quite different from what is required in commercial oil exploration where simple fast Fourier transform algorithms are adequate, he suggests.

Thun estimates Raytheon's total annual output of signal processors — which in some instances are large enough to fill "quite a number of


United States leads the way in DSP shipments

Worldwide shipments of DSP by region ($ millions)

Source: Electronic Trend Publications

TI's JOHN SCARISBRICK: Utilizing third party vendors is "the cornerstone of our support"

Ben Smusz

cabinets" — runs into the thousands. Raytheon is also investing approximately $50 million in the building of a gallium arsenide (GaAs) research and manufacturing facility in Andover, Mass., which is expected to produce some DSP products.

THE OBSTACLES

Succeeding in the DSP market takes more than deep pockets and technological expertise. Before the 1980 boom time, more than one prominent semiconductor manufacturer announced products that either quickly faded into the sunset or never hit the commercial streets.

Gould AMI Semiconductors, based in Santa Clara, Calif., announced in 1978 a DSP in VMOS, which "was not a successful product," says Strauss of Forward Concepts. "The yields were abysmal," he adds, and the company was never able to get out anything beyond samples. The company later came out with an improved process, but in the interim had started to second source NEC's chip. After realizing the NEC chip was outselling theirs by a wide margin, Strauss comments, Gould AMI dropped their own product and continues to second source the NEC DSP.

Although Santa Clara-based Intel Corp.'s 2920 DSP was considered "avant-garde" at the time of its 1979 announcement — it was the first microprocessor designed specifically for digital signal processing — because of its slowness (a 400 nanosecond cycle time compared to NEC's 100 nanosecond cycle time) the product "never made a nickle for them," says Strauss.

While AT&T produced a successful product before 1980, it was not until July of this year that the company manufactured a DSP available for commercial use. In the predivestiture days of 1979, AT&T announced DSP-1. However, both this product and its second generation DSP-2, introduced in 1983, were limited to internal use in AT&T systems products such as central office switches, private branch exchanges and cellular radios. This summer AT&T announced for commercial use the DSP-32, a 32-bit floating-point general-purpose single chip.

Despite the fact that NEC was the first company to begin shipping a successful general-purpose single-chip DSP in volume, its estimated 25% of this year's forecasted $94 million market pales beside that of Texas Instruments' TMS 320 line, which was introduced in 1982 and currently holds an estimated 68% of this market, according to Bader Associates. The difference has been marketing strategy, not product capability.

Indeed, when shopping around for a DSP to use in its newly introduced 9600 bits per second modem, U.S. Robotics Inc. went with a member of the Texas Instrument's TMS 320 family. Although the company considered other vendors' products, "TI had a good support system to go with developing a use for the chip," says Dale M. Walsh, vice president, engineering, at U.S. Robotics' research and development facility in Lombard, Ill.

In addition to design tools, test equipment for DSPs is also lacking

Originally, NEC limited its DSP applications to telecommunications, an area where the company knew the product would succeed, notes William Meshach, manager for application engineering for DSPs at NEC's Natick, Mass., facility. There was a great need for DSP capabilities in telecommunications, Meshach adds, and people would pay what they had to, to get the needed performance.

In the meantime, Texas Instruments was storming the market fields, conducting seminars all over the country, familiarizing design engineers with its products' capabilities and providing a broad range of software support, all in an effort to make ease of use a reality. The key in being able to offer so much support was in utilizing third party vendors, which John Scarisbrick, TI's DSP product manager, calls "the cornerstone of our support."

NEC is now working to narrow the gap. According to Meshach, his department includes six DSP application/development engineers dedicated entirely to developing DSP product support. In addition, NEC has added approximately 30 field applications engineers to service regions across the United States, all in an effort to expand NEC's customer base beyond telecommunications.

To date, however, industry watchers agree that no other vendor is on par with the depth of support offered by TI, and this lack of support remains a hindrance in the single-chip general-purpose segment of the DSP marketplace. Few companies can offer all the necessary support.

"From an economic point of view, there's no comparison between [using third party vendors] and doing it all oneself," suggests Honeywell's Karl Stjernquist, director of the Digital Product Center in Colorado Springs, Colo. As a result, Honeywell will develop some minor software programs, but will buy third party software whenever it's financially prudent.

Indeed, Atlanta Signal Processors Inc. (ASPI) in Atlanta is one of the more than a dozen new third party software companies addressing this need. Founded in 1982 to provide consulting and develop algorithms, its founders soon realized the industry suffered a lack of DSP knowledge within the engineering base. As a result, "for the next four to five years, our big role will be in creating development tools . . . encapsulating DSP design tools in CAD [computer-aided design] systems," says Thomas P. Barnwell, co-founder and vice president of engineering at ASPI.

In addition to design tools, test equipment for DSPs is also lacking. "There's a new class of tools that's missing," Barnwell points out. "For signal processing, algorithms require a level of testing that isn't simply verification. What's missing is the ability to effectively run real-time debugging [nonintrusively]."

From a customer's point of view, says John Ekiss, president and chief executive officer of Santa Clara-based Zoran Corp., there have been so many products introduced over the last 12 months, and so many claims being made, that there is a great deal of customer confusion. Ekiss also realizes that as long as confusion reigns, the cash register will not ring. And so, Zoran is "plugging away at the fundamentals, trying to educate customers [with] training courses, seminars and published materials."

Lack of education in the complexities of digital signal processing is a complaint of many DSP component vendors. But this weak spot seems to be affecting the lower end of the market rather than the high end. According to Christopher Ryan, DSP product marketing manager for Plessey Semiconductor in Britain, at the top end, where Plessey is focused, "engineers involved in radar, sonar and video processing know what they're doing."

In time, as current obstacles are resolved, new ones are expected to arise. "Five years from now the limitation will be an inability to design devices," says Honeywell's Stjernquist. Within 10 years, Stjernquist believes, there will be a market for one million gates per chip. The issue then will be how to design and manufacture the complex chip.

COST OF ENTRY

Becoming a contender in the DSP arena can cost less than $10 million or more than $50 million. The smaller the budget size, however, the more likely a company will choose high-end, niched segments. Companies earning only a few million dollars a year are anxious to avoid head to head confrontations with semiconductor Goliaths who spend more in a month on research and development (R&D) than the start-up Davids have to spend on an entire year's operating budget. (For example, AMD spent $164 million on R&D, their fiscal year ending March 1985. Texas Instruments spent $402 million in their fiscal year ending December 1985 [ELECTRONIC BUSINESS August 1, 1986 p92]. On the other hand, Weitek Corp. has raised a total of $7 million in venture capital since being founded in 1981 and the company still has $4 million of that in the bank.)

Ted Dintersmith, division general manager of Digital Signal Processing Inc., an internal division of Analog Devices, estimates that for a full-blown DSP start-up the costs are "certainly in the $50 million range." A new wafer fab facility might cost in the tens of millions of dollars, he estimates. In addition, a base of computer-aided design equipment can run into several million dollars and test equipment can run $2 million to $5 million "just to get going," says Dintersmith. At DSP Inc., two Teradyne J series testers, with million-dollar price tags, are included in the fab's equipment catagory. In addition to the cost of the wafer fab, the CAD equipment and basic computers that have a lot of computational ability, Dintersmith points out additional cash is needed for the internal structure including staffing, research and development costs, marketing and management teams.

The smaller the budget size the more likely a company will choose high-end, niched segments

Such expenses are out of the reach of companies like Weitek Corp. — a start-up that specializes in high-end, building-block DSPs. Since its incorporation in 1981, Weitek has raised $7.7 million in venture capital. Instead of building its own manufacturing facility, the company has opted to have others do it for them. This choice, however, has more to do with a business philosophy than with the lack of megabucks.

Suggesting that traditional semiconductor companies, "as structured, are nonviable," Weitek's Rizzo extols the benefits of subcontracting semiconductor manufacturing. Rather than having to worry every year about coming up with large amounts of revenue for fresh capital to invest in costly manufacturing equipment, Weitek spends most of its money on R&D, technology support and marketing. "We think it would be foolish to build a fab. Our unit volume doesn't support it, and we can get all the processing technology we need without investing in a fab," says Rizzo.

If $50 million is too hefty a sum, and contract manufacturing is not considered a viable solution, there is another way to become a DSP player. With less than a quarter of its $27 million raised in venture capital, start-up Zoran Corp. purchased a manufacturing facility out of bankruptcy, paying "25 cents on the dollar," says president and chief executive Ekiss. ☐

Top digital signal processor vendors

Worldwide shipments ($ millions)

Single-chip DSPs

	1986	1991
Texas Instruments	$64	$240
NEC	23	120
AT&T	0	54
Motorola	0	48
Analog Devices	0	36
Others*	7	101
Total	**$94**	**$599**

*Fairchild, Fujitsu, Hitachi, INMOS, Mitsubishi, National Semiconductor

Building-block components

	1986	1991
Analog Devices	$19	$50
Integrated Device Technology	19	47
Weitek	19	47
TRW	16	37
AMD	12	30
Others*	9	37
Total	**$94**	**$248**

*Bipolar Integrated Technology, Micro Power Systems, Stanford Telecommunications, Texas Instruments

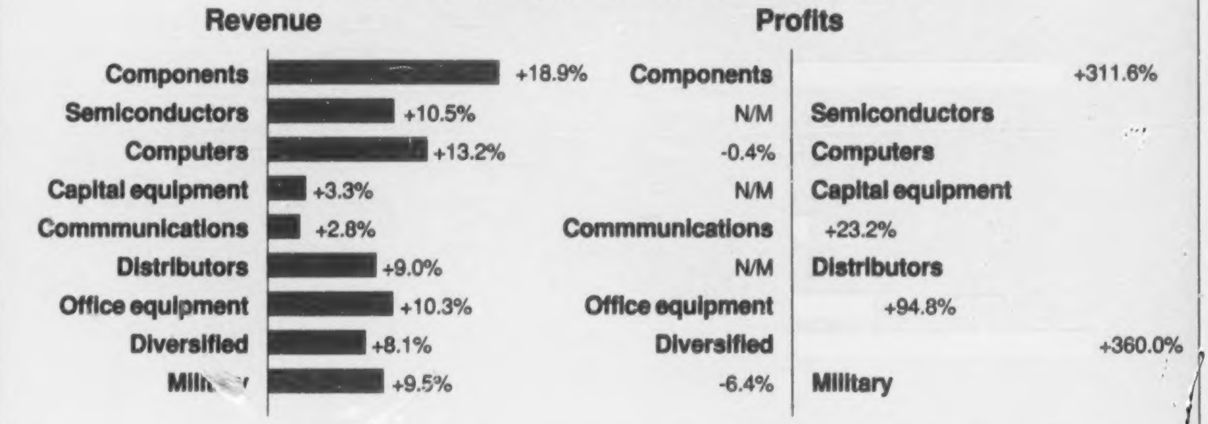
Source: Electronic Trend Publications

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 3rd quarter of 1985 to 3rd quarter of 1986



Components (Other than semiconductors)	Revenue 3rd quarter 1986 ($ millions)	Change from 1985	Profits 3rd quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
AMP	$481.4	+21.6%	$42.1	+94.8%	$1,426.7	+16.8%	$118.0	+37.1%	Sept. 30
AVX	$47.2	+12.9%	$0.4	N/M	$144.8	+6.6%	-$2.1	N/M	Sept. 28
Augat	$66.5	+5.5%	$2.5	-13.2%	$195.9	+2.8%	$7.0	-34.8%	Sept. 30
CTS	$62.0	-3.1%	$0.4	-66.6%	$180.0	-13.2%	-$2.3	N/M	Sept. 28
Molex	$93.0	+50.9%	$10.8	+72.8%	$257.7	+35.7%	$29.4	+39.6%	Sept. 30
Oak Industries	$34.7	+3.3%	-$4.2	N/M	$109.2	-4.5%	-$26.4	N/M	Sept. 30
Segment composite	$784.8	+18.9%	$52.0	+311.6%	$2,314.3	+12.4%	$123.6	+44.7%	

Semiconductors

Advanced Micro Devices	$157.7	+23.1%	-$46.9	N/M	$465.0	-3.1%	-$86.2	N/M	Sept. 28
Intel	$324.1	+4.0%	-$114.2	N/M	$909.4	-13.1%	-$156.7	N/M	Sept. 30
International Rectifier	$37.9	+8.0%	-$1.4	N/M	$113.1	+6.4%	-$4.7	N/M	Sept. 30
LSI Logic	$46.5	+34.3%	-$1.3	N/M	$139.8	+41.9%	$2.1	-66.1%	Sept. 30
National Semiconductor	$501.1	+22.6%	-$1.4	N/M	$1,221.2	-0.9%	-$47.9	N/M	Aug. 31
Texas Instruments	$1,248.9	+4.8%	$14.0	N/M	$3,638.3	-2.1%	$13.3	N/M	Sept. 30
Western Digital	$83.7	+33.0%	$8.2	+233.4%	$236.2	+44.6%	$22.3	N/M	Sept. 27
Segment composite	$2,399.9	+10.5%	-$143.0	N/M	$6,723.0	-1.7%	-$257.8	N/M	

Computers and peripherals

Amdahl	$220.0	-0.5%	$7.1	+24.6%	$629.6	+4.1%	$12.2	-18.4%	Sept. 26
Apollo	$100.4	+81.8%	$2.5	N/M	$270.8	+20.4%	$4.1	N/M	Sept. 30
Apple	$510.8	+24.7%	$32.9	+47.1%	$1,368.0	+12.1%	$97.0	+541.6%	Sept. 26
Burroughs*	$2,633.0	+127.2%	$52.9	+64.3%	$5,106.6	+43.5%	$145.1	+9.2%	Sept. 30
COMPAQ	$147.2	+11.8%	$8.7	+38.7%	$438.4	+26.1%	$26.7	+60.7%	Sept. 30
Control Data	$818.5	-8.5%	-$9.3	N/M	$2,443.1	-9.5%	-$38.3	N/M	Sept. 30
Convergent	$64.7	-44.9%	-$25.7	N/M	$228.4	-32.9%	-$28.4	N/M	Sept. 30
Cray Research	$136.6	+37.3%	$26.1	+36.8%	$458.5	+55.2%	$101.5	+59.6%	Sept. 30
Data General	$330.1	+10.2%	$4.6	+820.0%	$974.2	+7.6%	$4.6	+270.3%	Sept. 27
DEC	$2,038.5	+25.5%	$182.6	+152.5%	$6,142.5	+18.9%	$591.6	+123.7%	Sept. 27
Honeywell	$1,664.9	+6.1%	$32.4	-41.8%	$4,897.3	+6.5%	$94.7	-38.7%	Sept. 30
IBM	$11,910.0	+1.8%	$1,077.0	-26.9%	$34,305.0	+4.3%	$3,399.0	-12.3%	Sept. 30
Micropolis	$55.4	+151.2%	$4.9	+987.2%	$161.3	+174.8%	$13.1	+2,387.3%	Sept. 26
Prime	$221.9	+12.8%	$12.1	-20.6%	$629.2	+12.4%	$32.8	-18.7%	Sept. 30
Sun Microsystems	$91.6	+171.8%	$6.7	+570.0%	$225.8	+115.3%	$16.0	+151.7%	Sept. 26
Tandem	$220.6	+26.9%	$21.6	+94.2%	$597.7	+28.7%	$52.1	+156.2%	Sept. 30
Telex	$204.9	+19.1%	$19.4	+13.7%	$604.5	+19.3%	$54.4	+10.4%	Sept. 30
Segment composite	$21,369.1	+13.2%	$1,456.5	-0.4%	$59,480.9	+9.0%	$4,578.2	+4.3%	

* The latest quarter includes Sperry Corp.'s results as of September 16. Burrough's year-ago results do not include Sperry's year-ago results

N/M = not meaningful

Continued

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Capital equipment	Revenue 3rd quarter 1986 ($ millions)	Change from 1985	Profits 3rd quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
Computervision	$125.9	+19.1%	$1.2	N/M	$358.2	+10.6%	-$9.2	N/M	Sept. 30
Fluke	$52.4	+0.5%	$2.9	-22.2%	$157.4	-3.5%	$9.0	-20.8%	Sept. 28
GCA	$31.7	+6.5%	-$3.1	N/M	$102.3	-24.5%	-$4.0	N/M	Sept. 30
GenRad	$45.0	-9.7%	-$8.7	N/M	$142.8	-15.3%	-$28.4	N/M	Sept. 30
Spectra-Physics	$54.8	+0.9%	-$0.9	N/M	$160.1	+7.5%	$0.7	N/M	Sept. 30
Tektronix	$304.9	+0.8%	$14.6	+321.6%	$1,032.2	-5.9%	$37.7	-34.3%	Aug. 23
Teradyne	$83.0	+6.2%	$0.0	-94.3%	$232.5	-11.4%	$0.2	-99.2%	Sept. 30
Varian	$236.3	+1.9%	-$11.5	N/M	$693.4	-5.9%	-$16.6	N/M	Oct. 3
Segment composite	$934.0	+3.3%	-$5.5	N/M	$2,878.9	-5.2%	-$10.6	N/M	
Communications									
Andrew	$61.0	+5.8%	$3.2	-31.7%	$149.3	-6.3%	$7.2	-27.1%	Sept. 30
Aydin	$32.0	+1.3%	$1.7	+97.7%	$102.4	+4.7%	$5.4	+88.0%	Sept. 27
DSC Communications	$70.8	+4.0%	$3.0	N/M	$229.5	+9.0%	$8.7	N/M	Sept. 30
Dynatech	$72.2	+7.6%	$6.0	+8.7%	$205.3	+8.4%	$17.0	-3.0%	Sept. 30
General DataComm	$46.3	+8.3%	$0.9	+181.8%	$137.2	-1.3%	$2.4	-66.5%	Sept. 30
Micom Systems	$48.1	+2.1%	$2.8	+8.8%	$141.1	-2.8%	$6.1	-42.1%	Sept. 30
Northern Telecom	$1,030.0	+3.5%	$59.4	+1.7%	$3,070.0	-0.3%	$160.7	-15.4%	Sept. 30
Paradyne	$64.2	+11.1%	-$13.6	N/M	$197.4	+2.6%	-$12.6	N/M	Sept. 30
TIE/communications	$67.3	-20.3%	-$7.1	N/M	$234.3	-3.8%	-$13.3	N/M	Sept. 30
Segment composite	$1,491.9	+2.8%	$56.3	+23.2%	$4,466.5	+0.2%	$181.6	+10.5%	
Distributors									
Arrow Electronics	$127.6	+3.6%	-$8.9	N/M	$397.1	-4.2%	-$21.5	N/M	Sept. 30
Avnet	$363.1	+7.3%	$6.0	-20.0%	$1,100.6	+5.3%	$14.0	-44.2%	Sept. 26
Ducommun	$111.1	+11.4%	-$0.8	N/M	$347.8	+12.8%	-$0.5	N/M	Sept. 26
Marshall Industries	$70.5	+24.8%	$1.1	+518.9%	$202.5	+15.5%	$3.7	+178.6%	Aug. 31
Pioneer-Standard	$54.6	+11.8%	$0.2	N/M	$159.8	+3.0%	-$0.7	N/M	Sept. 30
Segment composite	$726.9	+9.0%	-$2.4	N/M	$2,207.8	+5.2%	-$5.0	N/M	
Office equipment									
Diebold	$100.4	+5.3%	$7.2	+32.2%	$303.7	+1.4%	$24.9	+24.7%	Sept. 30
NBI	$72.1	+3.1%	-$1.3	N/M	$213.3	+12.5%	-$6.4	N/M	Sept. 30
NCR	$1,176.9	+13.4%	$73.4	+2.3%	$3,306.5	+13.6%	$202.5	+11.3%	Sept. 30
Pitney Bowes	$495.3	+11.6%	$38.9	+18.6%	$1,423.3	+9.1%	$112.2	+20.6%	Sept. 30
Wang	$597.9	+6.6%	-$30.0	N/M	$2,000.0	+14.4%	-$7.8	N/M	Sept. 30
Xerox	$2,316.0	+9.9%	$112.0	N/M	$6,632.0	+7.6%	$335.0	+5.0%	Sept. 30
Segment composite	$4,758.6	+10.3%	$200.2	+94.8%	$13,878.8	+10.0%	$660.4	+23.1%	
Diversified									
General Instrument	$206.7	+10.0%	$3.0	N/M	$609.7	+1.0%	$13.4	N/M	Aug. 31
Gould	$227.4	-1.2%	$4.3	-72.6%	$681.4	-1.2%	$29.1	N/M	Sept. 30
Harris	$477.6	-15.2%	$16.3	+26.1%	$1,572.1	-10.1%	$48.5	+4.9%	Sept. 27
Motorola	$1,431.0	+10.0%	$31.0	N/M	$4,269.0	+6.9%	$131.0	+367.9%	Sept. 27
N.A. Philips	$1,084.3	+4.4%	$17.4	+29.9%	$3,175.6	+3.5%	$20.9	-61.9%	Sept. 30
Tandy	$742.6	+14.1%	$43.7	+4.8%	$2,126.8	+14.5%	$118.4	+0.7%	Sept. 30
Zenith	$513.8	+42.4%	$3.9	N/M	$1,295.0	+13.6%	-$10.4	N/M	Oct. 4
Segment composite	$4,683.4	+8.1%	$119.6	+360.0%	$13,729.6	+4.8%	$350.9	+372.8%	
Military									
E-Systems	$283.8	+17.8%	$16.4	+21.3%	$834.1	+21.6%	$46.7	+5.4%	Sept. 30
Electrospace Systems	$46.2	+33.0%	$0.9	-70.0%	$133.4	+38.6%	$7.4	-18.0%	Oct. 3
Hazeltine	$24.5	-41.9%	-$1.8	N/M	$85.6	-28.8%	-$5.4	N/M	Sept. 30
Logicon	$51.6	+1.6%	$2.2	-14.6%	$155.4	+11.4%	$7.1	-1.7%	Sept. 30
Loral	$157.5	+4.2%	$12.9	+5.5%	$518.4	+19.0%	$43.3	+20.9%	Sept. 30
Raytheon	$1,714.0	+9.6%	$101.5	+6.5%	$5,267.0	+12.2%	$293.6	+5.9%	Sept. 28
Tracor	$153.0	+12.5%	-$3.1	N/M	$460.8	+14.3%	$11.1	-47.4%	Sept. 30
Watkins-Johnson	$63.2	+9.6%	$4.3	-10.9%	$190.9	+10.8%	$13.7	+10.9%	Sept. 26
Segment composite	$2,493.8	+9.5%	$133.3	-6.4%	$7,645.6	+13.3%	$417.5	+0.6%	

N/M = not meaningful

Source: Dow Jones News/Retrieval

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	12	29	24	35	0	0	8.1	8.5
Pot-Core	11	34	33	22	0	0	6.9	7.3
Laminate (power)	6	25	31	38	0	0	9.0	8.9
CONNECTORS								
Military panel	40	20	40	0	0	0	3.6	13.8
Flat/Cable	28	39	33	0	0	0	3.4	4.6
Multipin circular	12	50	35	0	0	0	4.5	7.4
PC	6	65	12	17	0	0	5.1	7.1
RF/Coaxial	40	50	10	0	0	0	1.8	5.4
Socket	28	33	28	11	0	0	4.7	5.3
Terminal blocks	17	50	28	5	0	0	4.1	6.3
Edge card	19	31	31	19	0	0	6.1	5.9
Subminiature	18	39	36	9	0	0	5.1	7.3
Rack & panel	14	29	28	29	0	0	7.4	9.8
Power	0	50	50	0	0	0	5.0	8.2
PRINTED CIRCUIT BOARDS								
Single-sided	0	52	48	0	0	0	4.9	5.1
Double-sided	0	48	52	0	0	0	5.1	5.0
Multilayer	0	15	85	0	0	0	7.1	9.0
Prototype	4	91	5	0	0	0	2.2	3.0
RESISTORS								
Carbon film	44	37	19	0	0	0	2.2	3.6
Carbon composition	24	48	17	7	0	0	4.0	4.3
Metal film	36	27	32	5	0	0	3.8	3.8
Metal oxide	17	33	42	8	0	0	5.3	4.9
Wirewound	11	21	53	10	5	0	7.7	5.1
Potentiometers	9	37	17	35	0	0	7.7	5.5
Networks	30	40	20	0	5	5	5.2	6.0
FUSES	40	35	25	0	0	0	2.7	2.1
SWITCHES								
Pushbutton	6	50	33	11	0	0	5.4	6.4
Rotary	0	47	41	12	0	0	6.1	8.2
Rocker	18	41	35	6	0	0	4.6	5.8
Thumbwheel	0	45	33	11	11	0	8.2	6.8
Snap action	9	46	27	9	9	0	6.9	5.3
Momentary	0	57	29	14	0	0	5.7	6.4
Dual in-line	0	57	29	14	0	0	5.7	6.2
WIRE AND CABLE								
Coaxial	44	44	12	0	0	0	1.9	3.2
Flat ribbon	53	21	26	0	0	0	2.5	4.5
Multiconductor	60	27	13	0	0	0	1.6	5.3
Hookup	50	42	8	0	0	0	1.5	3.7
Wire wrap	36	50	14	0	0	0	2.1	3.4
Power cords	36	32	28	4	0	0	3.5	5.4
Other	33	0	67	0	0	0	5.3	6.0
POWER SUPPLIES								
Switching	0	46	54	0	0	0	5.2	9.3
Linear	7	43	50	0	0	0	4.8	7.3
CIRCUIT BREAKERS	14	29	50	7	0	0	5.7	6.8
HEAT SINKS	23	45	32	0	0	0	3.5	4.5

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	27	33	20	20	0	0	5.5	6.3
PC board	8	46	15	31	0	0	7.1	8.5
Dry reed	0	33	34	33	0	0	8.7	9.2
Mercury	0	60	20	20	0	0	6.0	8.4
Solid state	27	36	9	10	18	0	7.6	10.0
DISCRETE SEMICONDUCTORS								
Diode	32	44	16	8	0	0	3.4	4.8
Zener	28	28	33	11	0	0	5.0	5.9
Thyristor	38	25	25	12	0	0	4.5	8.0
Small signal transistor	20	40	27	13	0	0	5.1	7.0
FET, MOS	9	27	46	18	0	0	7.1	8.9
Power, bipolar	22	22	33	22	0	0	6.7	7.6
INTEGRATED CIRCUITS, DIGITAL								
CMOS	10	58	21	11	0	0	4.5	7.8
TTL	13	50	31	6	0	0	4.5	6.5
LS	21	47	21	11	0	0	4.3	6.7
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	25	50	12	13	0	0	4.0	8.9
OP amplifier	4	45	27	14	5	0	6.5	6.9
Voltage regulator	19	50	19	12	0	0	4.5	5.4
MEMORY CIRCUITS								
RAM 16k	30	30	30	10	0	0	4.6	6.1
RAM 64k	42	25	17	16	0	0	4.5	5.3
RAM 256k	10	50	20	20	0	0	5.8	6.0
ROM/PROM	25	25	17	33	0	0	7.2	7.7
EPROM	27	33	20	20	0	0	5.5	5.4
EEPROM	11	33	22	34	0	0	7.8	6.4
DISPLAYS								
Panel meters	18	27	27	28	0	0	7.1	7.7
Fluorescent	0	25	50	25	0	0	8.5	10.0
Incandescent	0	20	50	20	0	0	8.4	10.3
LED	14	38	43	5	0	0	4.9	5.6
Liquid crystal	12	37	13	38	0	0	7.8	8.5
MICROPROCESSOR ICs								
8-bit	18	27	27	28	0	0	7.1	7.6
16-bit	13	62	13	12	0	0	4.3	9.1
FUNCTION PACKAGES								
Amplifier	17	33	33	17	0	0	6.0	9.5
Converter, analog to digital	0	30	20	50	0	0	10.2	8.5
Converter, digital to analog	0	12	38	50	0	0	11.3	9.2
LINE FILTERS	9	46	36	9	0	0	5.3	8.5
CAPACITORS								
Ceramic	31	31	21	17	0	0	5.0	6.3
Ceramic monolithic	31	21	32	16	0	0	5.5	5.9
Ceramic disc	30	35	25	10	0	0	4.3	6.5
Film	27	36	28	9	0	0	4.4	6.7
Electrolytic	17	29	37	17	0	0	6.3	5.8
Tantalum	17	27	37	17	0	0	6.3	7.2
INDUCTORS	14	38	43	15	0	0	6.3	6.8

Source: *Electronics Purchasing* magazine's survey of buyers

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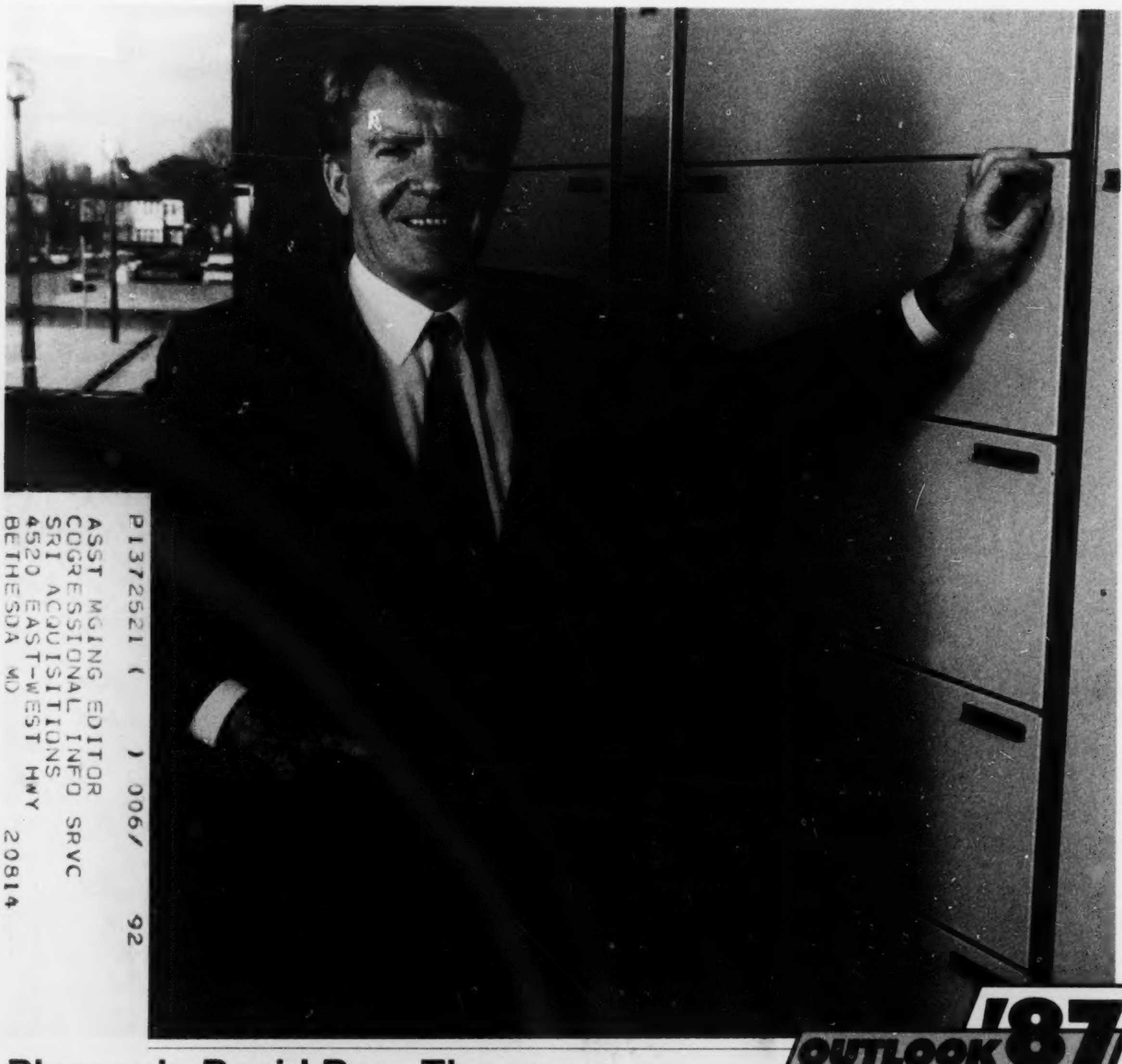
JANUARY 1, 1987

Electronic Business

Image processing's picture-perfect opportunities

CASE: The growing market for software that writes software



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OUTLOOK '87

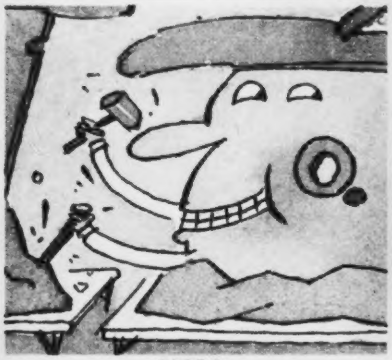
Plessey's David Dey: The sun shines on a $2 billion empire

Electronic Business

VOL. 13, NO. 1

JANUARY 1, 1987

THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY



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33 The patent has expired, but vital signs are stable
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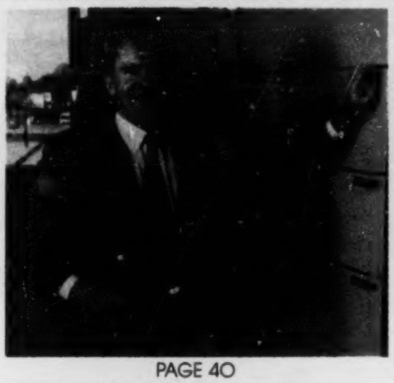

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Britain's No. 2 electronics manufacturer resisted being swallowed by GEC. What's next?

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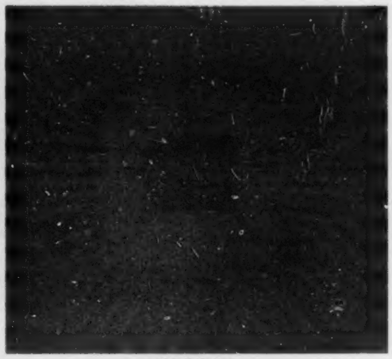
When Casey came to bat, he aimed at technical sales. But OEMs and resellers also wanted to play.



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VBPA ABP

Last quarter's profits may set the tone for 1987

Key to profits for this year are a recovery in demand for chips accompanied by firm prices

For the ELECTRONIC BUSINESS index for revenue, 1986 had the dubious distinction of registering the slowest growth in the past 10 years. Still, growth there was, so the index reached its highest level ever. For the profits index, however, the picture was far more negative. It was the first time in 10 years, the period the magazine has kept track of the activity by electronics companies, that this index declined from the previous year.

The profits index had already started 1986 on a very low note, by sliding in the first quarter to its lowest level in three years, but it may have ended the year on its way up, as the cost cutting measures many companies have implemented show their impact on the bottom line. The challenge for management in 1986 was to make their companies leaner without cutting into the bone. To bring cost, which was bloated from the expectation of higher business levels, in line with actual revenue while at the same time providing for future growth. "Our most important goal [for 1987] is to add to profits and improve [their] consistency," says Jerry R. Junkins, president and chief executive of Texas Instruments Inc.

This company, which derives its revenue from semiconductors, defense electronics, computers and oil exploration, provides a good example of the ills that affected the electronics industry in the past two years and of the opportunity for overcoming them. Semiconductors still are not profitable, but TI has been cutting losses and expects a profitable year in 1987. Profits for defense electronics have been stable all along. For computers, they turned from red to black in 1986. Oil exploration, on the other hand, has moved in the opposite direction, driven by low oil prices.

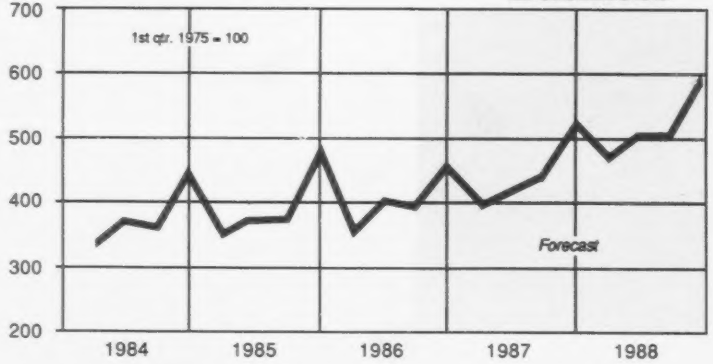
Other companies which, along with TI, are among the 16 that this magazine tracks to build the ELECTRONIC BUSINESS indexes for revenue and profits, have behaved similarly. Chip makers Advanced Micro Devices Inc. (AMD) and Intel Corp. have seen their bottom lines worsen through the first three quarters of 1986 but expect that cost controls and improving semiconductor sales have cut losses in the last quarter and will put them in the black for 1987. Texas-based defense electronics contractor E-Systems Inc. has been, in 1986, consistently profitable and ahead of 1985. Computer manufacturers are a mixed bag. They were profitable in 1986, but their balance was heavily upset by IBM's eroding bottom line. Digital Equipment Corp., buoyed by the success of the MicroVAX addition to its already successful VAX line of minicomputers, turned in a sterling profit performance last year, and expects to continue doing so in this one. Profits at Hewlett-Packard Co. and Honeywell Inc. held even but low in 1986 and may not improve much in 1987.

Cahners Economics estimates that revenue grew only 2% while profits lost 6% in 1986. Economist Cheryl Patstone forecasts that both indexes will make parallel gains in 1987 — 11% for revenue, 12% for profits. Such performance would depend heavily on the same factor that AMD, Intel and TI hope for; a recovery in the demand for semiconductors accompanied by firm prices for chips.

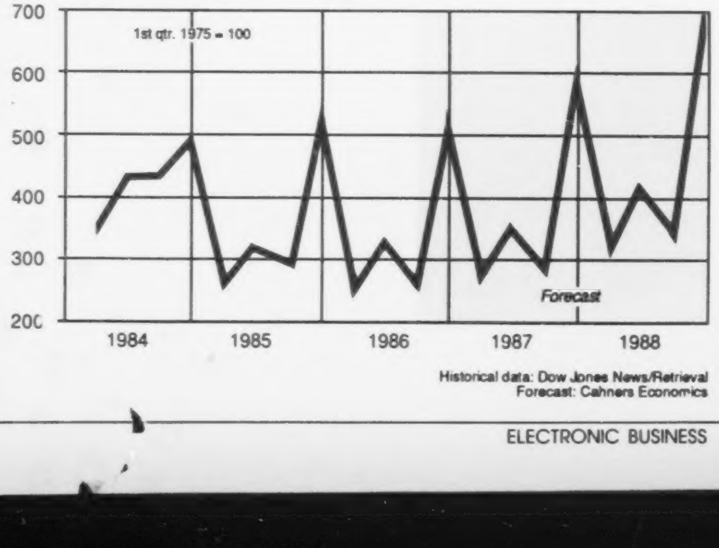
ALBERTO SOCOLOVSKY

Electronic Business

Revenue index



Profit index



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For the year, production is expected to be up a scant 0.9% from last year. Next year, steady improvements are forecast thoughout the year pushing production up 3.9% in 1987.

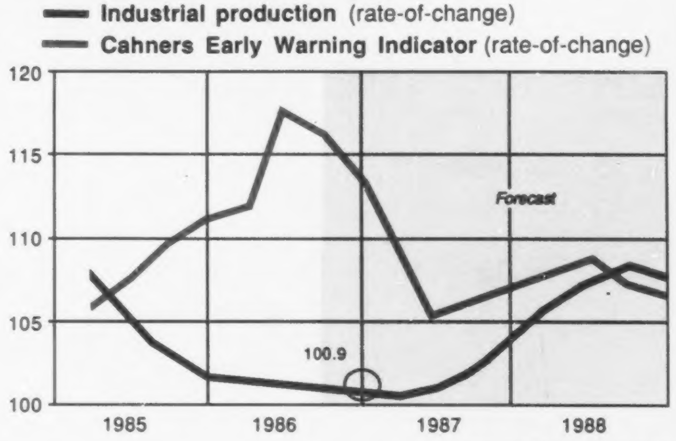
The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.9 level forecasts using the CEWI for the end of this year indicates that the average for all of 1986 should be 0.9% above 1985.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

ATE revenue and profit

In the third quarter of 1986, revenue for automatic test equipment manufacturers showed an 8% increase from the prior quarter and was up 9% from the year-ago quarter. This was the first quarter-to-quarter gain since the beginning of 1985. The gradual improvement in the third quarter along with fourth quarter revenue expected to show an even sharper increase, when demand from computer and semiconductor manufacturers for automatic test equipment strengthens, seems to signal a climate of cautious expansion. Following a strong 42.4% gain in 1984, sales fell 14.4% in 1985. Despite a gradual improvement in the second half of 1986, revenue is expected to drop 2.7%. This year a 12.2% increase is forecast, followed by a sharp 25.3% rise in 1988. Earnings of ATE manufacturers showed a slight profit for the first time in over a year. Profits are expected to continue to strengthen through the next two years.

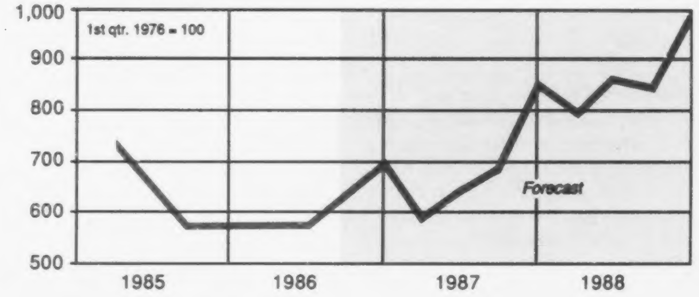
Economic indicators



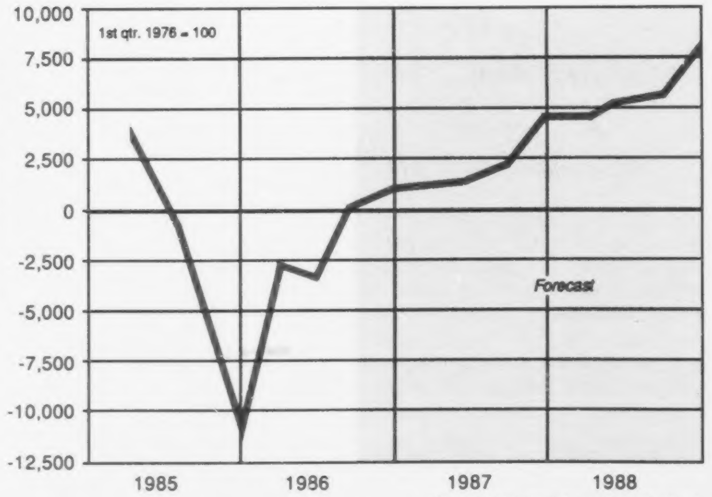
Historical data: Federal Reserve Board
Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

LETTERS

Insightful thanks

Just a note to say how much I enjoyed your article on Toshiba in last week's ELECTRONIC BUSINESS [Sept. 1, p46]. Your insight into their strategy in computers and their tactical response to the current challenges of the rising yen and dumping charges was very stimulating.

Thanks for an excellent overview on a key strategic customer/competitor/partner for Hewlett-Packard.

RICHARD C. WATTS
Marketing Manager, Design Systems Group
Hewlett-Packard
Fort Collins, Colo.

A secure correction

I am writing to correct an error in your recent story on security system markets [ELECTRONIC BUSINESS, Oct. 15, p106]. In fact, U.S. demand for X-ray inspection equipment, metal detectors and bomb detectors in 1985 was closer to $60 million. Further, growth in demand through 1990 will be just over 17% annually.

AMADEE BENDER
President
Worltech Reports
Northport, N.Y.

An American product

I very much enjoyed your article on PC compatibles in the August 15th issue, ["PCs: Turning back the Far East tide," p48] as my company is part of this exciting industry. However, I must take issue with two items.

First, it's ironic that you chose PC's Limited as an example of American manufacturing, since they made their name importing low-end Taiwanese products. I examined their turbo computer, and found a Japanese motherboard and a Taiwanese case and power supply. I don't believe Mr. Dell does more than final assembly in the U.S.

Second, I perceived a little bit of "hooray, we're beating Japan" in the article. A more compelling question is domestic vs. imported in general. Consider switching power supplies (a small circuit board with few parts) as an example. It doesn't appear to be sensitive to labor costs, yet the Taiwanese can sell me a 130-watt model for $50. The U.S. makers want upward of $100!

I must conclude that the Taiwanese pay less than we do for all their components. I've been told by Taiwanese makers that their costs for Texas Instruments TTL chips are lower than my cost in the U.S. I would like to see an article on component pricing in the various countries.

By the way, Proto PC manufactures a truly U.S.-made XT motherboard. Our XT16 uses high-tech parts from VLSI Technology, Standard Microsystems and NCR (on-board DRAM, Floppy and SCSI controllers) and is a very fast, extremely high-quality product.

RICHARD HAGER
President
Proto PC Inc.
St. Paul, Minn.

A calculated defense

I just finished reading the listing of the top 40 defense contractors in the August 15 [p90] issue of ELECTRONIC BUSINESS. I'm not sure if the omission occurred on your side or our side, but Control Data Corp. should have been included in your listing.

All of the relevant information is available in a recent prospectus, which I have enclosed for you (the appropriate segments are marked). With a few simple calculations, it's easy to see that Control Data's defense business resulted in approximately $330 million in revenue in 1985. This number clearly adds us to your top 40 listing.

KATHRYN J. WARDROP
Manager Corporate Public Relations
Control Data Corp.
Minneapolis, Minn.

Rave review

I just read your interesting memo in the October 15 issue [p9] of ELECTRONIC BUSINESS and would like very much to receive your list of Japanese firms' planning investments for overseas production.

One question. Being from a Business Analysis group at a semiconductor manufacturing plant, my interests are naturally oriented toward that market. Do you see the same opportunities existing, as mentioned in your memo, for the semiconductor market in Japan? Or is any potential opportunity in that market negated by the adverse (to the U.S.) effects of the antidumping pact between the U.S. and Japan? What are your thoughts?

In my job as Information Resources Analyst I read and review many of the electronics and business magazines on the market today and critique (abstract) articles of relevance to competitiveness in the electronics industry that have bearing to the computer and semiconductor fields. I find your magazine both relevant and insightful, and look forward to reading it every other week. Keep up the good work.

MARK A. DESROSIERS
Business Analysis
IBM Corp.
Essex Junction, Vt.

J. Chat Kelly, Vice President/Publisher responds:

Thank you for your letter responding to my article, "Where are the American companies."

Regarding the semiconductor manufacturers, the future appears to be in developing strong and lasting partnerships between shores. The first to sign up after the trade agreements, where approved, was National Semiconductor and the Japanese foundry, NMB. The Fujitsu/Fairchild merger is another example.

I submit that in five years it will be difficult to distinguish between a Japanese and American semiconductor industry; it will be a global industry with manufacturing and design facilities located near the customer to provide the most important product attribute — service.

Corrections

In the story "Military ATE: Here comes the 'Mod Squad'" [Oct. 1, p62], General Electric Co.'s partners on the Navy test system bid were misidentified. GE is teamed with Astro Systems Inc., Honeywell Inc. and Northrop Corp.

In the article "National strategies for regional distributors" [Oct. 15 p75], the correct spellings are Gordon Taplinger and Herbach & Rademan.

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers. If not written on organizational letterhead, all letters must include a telephone number. ELECTRONIC BUSINESS reserves the right to edit letters.

ELECTRONIC BUSINESS
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A slowdown in orders for fiber-optic cable

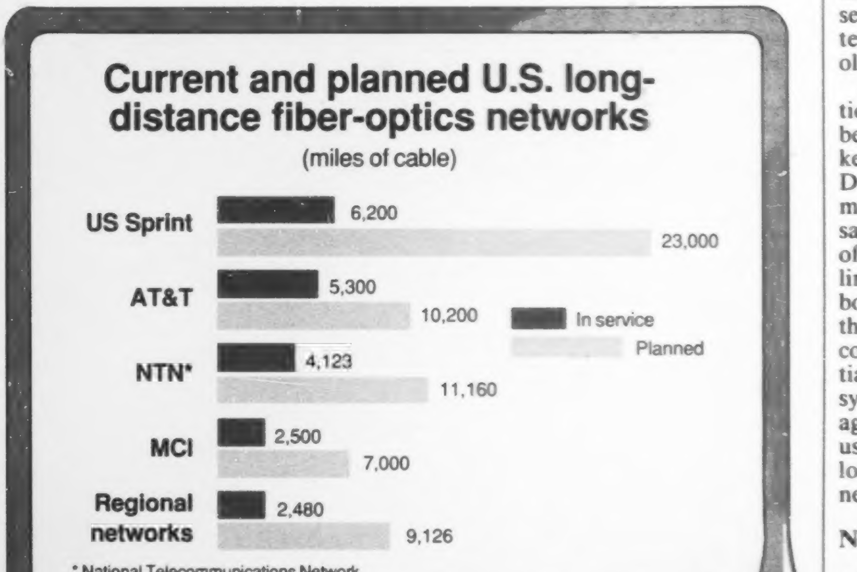
But, most vendors say that they are not worried because new applications are expected to come soon

Fiber-optic cable sales are losing some of their momentum as long-distance telephone companies draw closer to completing their domestic fiber networks. Although more than 40,000 miles of cable are scheduled to be laid in the next several years, no new, major orders have materialized. So the major players — AT&T, MCI Communications Corp., U.S. Telecom and the seven members of the National Telecommunications Network — have to be content with winding down their backlog of orders as they wrap up the last of their connections to domestic networks.

To date, 60,486 miles of cable are planned for the domestic market by the five largest carriers. About 20,603 miles of cable are now in service, according to the "Fiber Optics & Communications Newsletter." AT&T is also laying fiber optics across the Atlantic and Pacific oceans. With so much capacity becoming available, the long-haul companies are now hard at work trying to market the advantages of optical fiber to business customers.

Currently, fiber-optic technology permits a strand to move about 565 million characters of information a second. By 1988, that capacity is expected to reach 1.2 trillion characters a second, enough to allow a pair of cable strands to carry 16,000 voice conversations at once. More capacity will be reached when breakthrough equipment permits the movement of light signals in both directions at once on the same strand. In addition, the long-distance carriers foresee the need for more capacity in the future as telephone systems — and even high-definition television broadcast systems — are used more for data and video transmission. As a result, market research firms and fiber-optics companies alike claim that the current optical fiber cable slowdown is only temporary.

> Order reduction has been felt by all of the biggest fiber-optics makers



Current and planned U.S. long-distance fiber-optics networks

(miles of cable)

* National Telecommunications Network

Source: "Fiber Optics & Communications Newsletter"

Still, the order reduction has been felt by all of the biggest fiber-optics makers. In November of 1985, for example, AT&T laid off 184 workers in the fiber-optics division of its giant Norcross, Ga., plant. That was followed by an August, 1986 layoff of 206 employees in the optical fiber and cable division. The plant employs about 3,700 and about 60% of the facility's capacity is devoted to fiber optics, the remainder is copper wire.

"There has been a lot of consolidation in the long-haul telephone business," says J.A. Jeffries, manager for AT&T's lightguide fiber and cable engineering operations at the company's Atlanta works. He says that some of the expected orders never materialized when long-distance companies combined their fiber-optic networks. But advances in the equipment used to transmit and receive optical signals have increased the capacity of fiber-optic cable, says Jeffries, and even greater strides are expected.

AT&T's competitors, particularly Corning Glass Works, have also noted a downturn in orders. The company reduced its fiber-optics workforce by 115 employees in 1986 and more layoffs are expected. Corning says that the slowdown in fiber-optics orders seems to be caused by a lag of local telephone companies replacing their old copper lines with fiber optics.

Both AT&T and Corning, the nation's largest producers of optical fibers, are trying to develop other markets for the medium. Charles W. Deneka, Corning's manager of new market development for fiber optics, says that Corning is looking at the use of optical fibers as communications lines between components or circuit boards in electronic equipment. Further out is the use of optics inside the computer chip itself. Another potential market is short-haul, underwater systems, across large lakes or archipelagoes, where repeaters (amplifiers used to boost optical signals during long-haul transmission) may not be necessary.

New applications

There are also potential applications within the telephone industry, outside the basic transmission of voice, data and video signals, says Peter A. Woog, AT&T's director of product management for media products at the Norcross works. "The next thing to come is photonic switching systems," Woog says, which are switching systems based on light signals instead of electromechanical or electronic techniques. Military uses are also being investigated. Currently under study, for example, are air-to-surface missiles attached to aircraft by optical fibers that spin off a reel when fired.

But all of the prospective uses have been slow in developing and they do not consume large quantities of optical fiber. Frank Dixon, president of Electronicast Corp. of San Mateo, Calif., believes that the need for fiber optics in local telephone systems will be the only market large enough to provide the sustained demand for fiber cables for a long time to come.

"There's been a leveling or slight drop in fiber-optic cable orders," Dixon says. He calls the slump a "slight aberration." Electronicast expects heavier usage of fiber-optic networks from the business sector to stimulate demand for local telephone companies to speed up installations. Total fiber-optic cable production for the U.S. market could reach 1.8 billion meters by 1990, Dixon says, up from the 492 million meters expected in 1986. And Business Communications Co., a market research concern, predicts a 16% growth in fiber-optics revenue between 1985 and 1995. Revenue, by 1995, is expected to meet $982 million compared with $227 million in 1985. Seventy percent of that market will be absorbed by the telecommunications industry, and electronics and other industries will buy the rest.

The big enchilada

"The local loop is the biggest market by far," says Deneka. "The big enchilada is the home, where [video-based] broadband switched networks will provide services such as high-definition television." Deneka says that such services, however, will not be available until the late 1990s. Some companies, though, are moving faster than others. Southern Bell Telephone and Telegraph Co., for example, which serves Georgia, Florida and the Carolinas, reports that by the end of 1986, the company had expected to install cables containing 186.3 million meters of fiber. For the past year this telephone utility, one of two operating companies owned by Atlanta-based BellSouth Corp., had been installing a higher capacity, single-filament fiber.

Besides connecting some business customers with fiber, as well as installing some trunk lines in major cities in its service area, Southern Bell is also currently studying residential installation. A large subdivision in Orlando, Fla., already has been hooked up to cable as part of a Southern Bell experiment.

"Fiber optics is just like any other technological breakthrough," explains Dixon of Electronicast. "There are applications we don't know about right now." One potential market would be the delivery of high-definition, digital television, he says. Such televisions would require a transmission line capacity of 140 megabits per second for each channel.

"Nothing can do that but fiber," Dixon says.

ROBERT SNOWDEN JONES

Jones is an Atlanta-based business writer

The patent has expired, but vital signs are stable

There is still life remaining in the dry film photoresist market. Postmortems on premier suppliers were premature

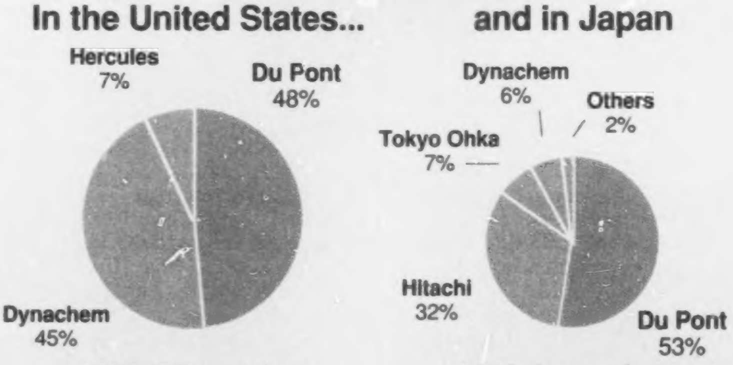
Before the 17-year-old Celeste patent held by E.I. du Pont de Nemours & Co. expired last fall, speculation ran rampant that a dozen new companies, mostly Japanese, would soon enter the U.S. dry film imaging market, valued anywhere between $120 million and $150 million. Heightened competition, the thinking went, would collapse prices and force Du Pont to exit the market.

To date no major part of this scenario has been played out. The U.S. market continues to be dominated by Du Pont with 48% market share and Morton-Thiokol Inc.'s Dynachem Division with 45%. Only Hitachi Ltd., among the Japanese players, has announced its intention of competing here. And only two or three other U.S. companies are serious about taking on Du Pont and Dynachem. Pricing, meanwhile, has held fairly steady at 26 cents to 28 cents per square foot of 1.5-mil film, although there are reports of giant customers such as AT&T or IBM purchasing dry film photoresist for under 20 cents because of their volume purchases.

Stable pricing and lack of new competition is due, in large part, to Du Pont's longevity in dry film photore-

Du Pont remains strong in dry-film photoresist

Percentage of market



1986 U.S. market
$120 million to $150 million

1986 Japan market
$40 million to $60 million

Source: Gene Weiner & Associates Inc.

sist materials. When Du Pont scientist Jack Celeste, in 1969, patented the process of making printed circuit boards (PCBs) using dry film photoresist material — Riston in Du Pont's case — to image the circuit patterns, it represented the only technology for high-yield imaging of fine-line circuit boards.

The Du Pont patent was the foundation of the company's commercial success in printed circuits. Analysts estimate that Du Pont's Riston Products Division now controls 55% of the approximately $250 million worldwide dry film photoresist market. During the past two decades the giant chemical company has realized millions of dollars in revenue from royalties and licensing fees in connection with the dry film patent. Company officials estimate that Du Pont's annual sales reached $1.3 billion last year.

Mistaken judgement

"Many people misjudged the situation," Gene Weiner says of those that believed the patent's expiration would turn the market topsy-turvy. Explains the Danbury, Connecticut-based consultant and former Dynachem marketer: "Not only does it take a good product to enter this market, but to be truly competitive requires an enormous outlay in research and development and in technical service and support. . . . Du Pont and Dynachem have made major investments over many years and catching up to them is very difficult."

Service is especially important for material suppliers because their customer base is composed largely of little board shops that depend on their film suppliers for engineering help beyond the normal level of support. "This dependency makes it all the more crucial that the vendor be a highly capitalized company like Du Pont," says Nicholas Pearne, director at BPA Technology & Management Ltd., a British-based market research firm.

Worldwide currency fluctuations also are inhibiting new competition. In particular, the 50% appreciation of the yen since mid-1985 has made it uneconomical for potential Japanese competitors to manufacture dry film resist in their home market and ship it to the United States. Consultant Weiner estimates that the current cost of manufacturing a square foot of dry film photoresist in Japan is more than the average unit selling price in the States.

Couple the currency problem with the electronic industry's recession and the shakeout among U.S. merchant and captive PCB fabricators, says Weiner, and suddenly the dry film market has lost some of its allure to potential entrants.

The scorecard

The existing players in the worldwide market for dry film photoresist materials, besides Du Pont and Dynachem, include: Hercules Inc., Du Pont's big neighbor in Wilmington, Del., with an estimated U.S. market share of 7%; Hitachi, which has an estimated 32% of the Japanese market; and two European firms, BASF and Kalle, the latter a unit of Hoechst AG. But, neither European company has a significant share of its home market, nor are they taken seriously as global competitors.

Among the companies involved in dry film research and development (R&D) are an estimated seven to 10 Japanese firms, including Fuji, Mitsubishi Electric Corp. and Asahi Chemical; and two U.S. companies, the Christopher Group (a California startup founded by a former Dynachem executive) and Minnesota Mining and Manufacturing Co. (3M). The Christopher Group is reportedly looking for financing to bring its film to market, while 3M is said to be developing a positive dry film resist for niche applications for inner layer printing and etching. But, of all of these potential entrants, Fuji is widely seen as the most likely to have a future market impact.

Service is especially important for material suppliers because their customer base is composed largely of little board shops

James Hickman, marketing manager for the Riston Division of Du Pont, argues that even a new competitor with vast financial and technical resources will have trouble gaining immediate market share. Board shops, many of which are undercapitalized, are loathe to spend tens of millions of dollars to changeover their processes to accommodate new vendors.

Nevertheless, Hickman does not dismiss the long-term threat of the Japanese — particularly in the Far East, where the PCB industry is expected to experience its greatest growth. Mindful of the threat, Du Pont has launched a number of major dry film photopolymer R&D projects, including a technical venture with Lea Ronal Inc. to develop an automated PCB chemical plating process. The company, also, has doubled its dry film manufacturing capacity in the belief that the U.S. PCB market alone will grow 50% to 55% over the next four years to nearly $6 billion in 1990.

Dynachem also has major R&D programs in the works, including one project to use electrodialysis to control electroless copper baths in PCB manufacturing. The No. 2 dry film photoresist company does not feel threatened, however.

"After Celeste, it will be business as usual," says Daniel Feinberg, vice president of marketing and sales for Dynachem. Although he expects a handful of companies to filter in and out of the market as they have in the past, the Dynachem executive is confident that his company and Du Pont will continue to dominate the market.

"I know of only two ways a newcomer is going to gain market share in the U.S.," Feinberg says. "Either cut prices or deal with risky credit accounts. Those are not good long-term strategies."

Customer perspective

Users of dry film resist see the current U.S. market as a two-horse race. Bruce Sorensen, vice president for engineering at Diceon Electronics Inc., the fourth largest merchant PCB house with 1985 sales of $55 million, initially expected a flood of new competition in the wake of the Celeste patent's expiration. But he has changed his mind, explaining: "The market is too controlled for that to happen."

Dry film will continue to prevail over liquid photoresist materials, Sorensen predicts. "We don't see liquid imaging chemicals being a factor at all," he says. Although some analysts predict wet resists will comprise up to 20% of the market by 1990, most observers think liquid photoresist materials will have a major impact on solder masking, rather than on mainstream etching or plating applications.

Regardless of which technology prevails in the future, there is little doubt which one has been king of the hill in the past. Observes market researcher Pearne: "I don't believe you will ever see a patent so completely dominate a market the way Celeste did."

MARK MEHLER

Electronics in 1987: A reason to believe

Remember double-digit growth? Remember growth at all? Do not despair, you are now in the year of the turnaround

By Norm Alster

Although most economists view 1987 with only restrained enthusiasm, there is reason to believe the electronics industry will rebound strongly. Indeed, 1987 may prove to be a surprisingly good year for many sectors of the U.S. economy.

Improvement will be welcomed by manufacturers of electronic equipment. In 1986, troubled customers in the energy, banking and manufacturing sectors cut back on capital expenditures and U.S. production of commercial electronic equipment grew by just 2.9%, according to Henderson Ventures, a Los Altos, Calif., research and consulting firm.

When IBM chief executive John Akers attributed his firm's sales slump last year to weak capital spending, he was tacitly conceding the increasingly cyclical nature of the electronic equipment business. The industry is now so large, and its penetration of industrial and commercial life so thorough, that it can no longer achieve meaningful growth simply by expanding its applications or base of customers. Industry fortunes are ever more dependent on the broader cyclical patterns of the economy.

Edward Henderson, president of Henderson Ventures, believes that a strong 4.1% expansion in the U.S. gross national product will help trigger an industry turnaround this year. Although he expects military electronic equipment to grow by little more than 3% to $51.8 billion, Henderson expects U.S. production of commercial electronic equipment to grow by 13.4% to $140.8 billion. Henderson expects computer and office equipment to lead the way with 14.1% growth. The industrial and instrument sector (13.2%) and communications equipment (12.3%) should follow close behind. U.S. semiconductor consumption will reflect the revival, expanding by almost 22% after two weak years.

Henderson's vision of renewed double-digit revenue expansion is predicated on a somewhat optimistic outlook of the overall economy. Most economists are less sanguine. Four bellwether forecasts — from the Business Council, Data Resources Inc., the National Association of Business Economists and Wharton Econometric Forecasting Associates — all cluster around a projected 3% growth in GNP. Predictions of recession and boom are equally scarce.

> Industry fortunes are ever more dependent on the broader cyclical patterns of the economy

"Vigorous economic growth will elude us," the oracular Henry Kauffman, chief economist for Salomon Brothers, informed the Conference Board Inc.'s annual business outlook conclave in New York City. Kauffman and other economists are wary for a number of reasons. The U.S. budget deficit continues to siphon capital from productive investment. The merchandise trade deficit is as stubborn as it is large. The new tax reform legislation is expected to have "some dampening effect" on capital spending, in the words of Priscilla Luce, director of Wharton's industrial analysis service. And no one is quite sure that spendthrift consumers will continue to pile up record debts.

"The thing that does worry us is the level of consumer debt. Debt is very high. Saving is very low," says David Wyss, senior vice president with Data Resources. Encouraged by a series of tax cuts, the U.S. consumer has been a marvel of profligacy since 1983. As a result, total household liabilities now amount to 65% of the gross national product, according to Data Resources. In 1980, by contrast, they were 55% of GNP and in 1975, just 50% of GNP. "The average family owes over ten months of its disposable annual income," according to Wyss.

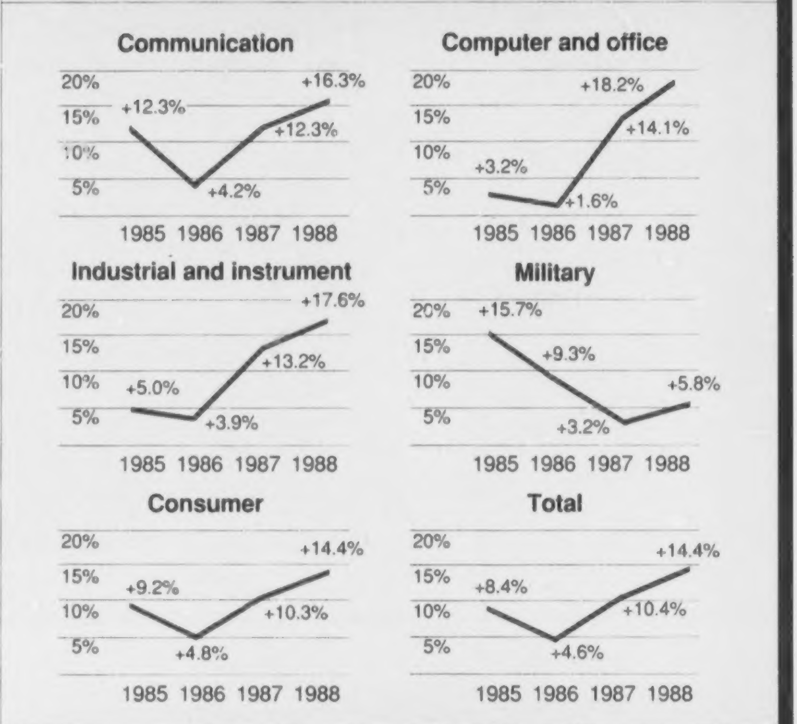
A sober outlook

If the consumer is suddenly overcome by fiscal sobriety, business is not considered likely to pick up the spending baton. For one thing, U.S. industry is operating at relatively low capacity, just under 80%. Historically, capital spending does not really kick in until industry is at 85% capacity utilization, according to Wyss. Also a depressant is the new tax legislation which lengthens depreciation schedules and eliminates the Investment Tax Credit (that allowed businesses to write off 10% of equipment purchases against their taxes). "In general, there's a slight bias against capital spending in the bill," says Wyss. DRI forecasts a 2.5% decline in capital spending in 1987.

The National Association of Business Economists is only slightly more optimistic, foreseeing a rise of less than 1% for the year. "There's concern that the implementation of the new tax law will be a mild depressant in early '87," reports NABE president

Electronic equipment

Annual growth in U.S. production



Source: Henderson Ventures

Electronic equipment

U.S. production ($ billions)

	1985	1986	1987	1988
Communication	$30.013	$31.286	$35.138	$40.869
Computer and office	58.051	58.957	67.244	79.477
Industrial and instrument	32.694	33.970	38.444	45.196
Military	45.896	50.160	51.759	54.782
Consumer	13.621	14.279	15.750	18.023
Total	**$180.275**	**$188.652**	**$208.335**	**$238.347**

Source: Henderson Ventures

Jerry Jordan, also senior vice president and chief economist with First Interstate Bancorp in Los Angeles, "but momentum will pick up as the year progresses."

Excising the worry warts

With consumer and business spending so problematic, some economists have trained their hopes for economic stimulation on the trade equation. This is the issue that truly separates the optimists from the worry warts. Pessimists argue that the devaluation of the dollar against the yen and key European currencies is simply not enough to improve the competitiveness of U.S. goods both inside and outside of the United States. They point out, moreover, that the dollar has not declined against the currencies of Korea, Taiwan and other trade rivals. These pessimists conclude that the trade deficit, which has shown only spotty signs of improvement, will endure since it reflects the abiding weakness of so many American firms in so many intensely competitive international industries.

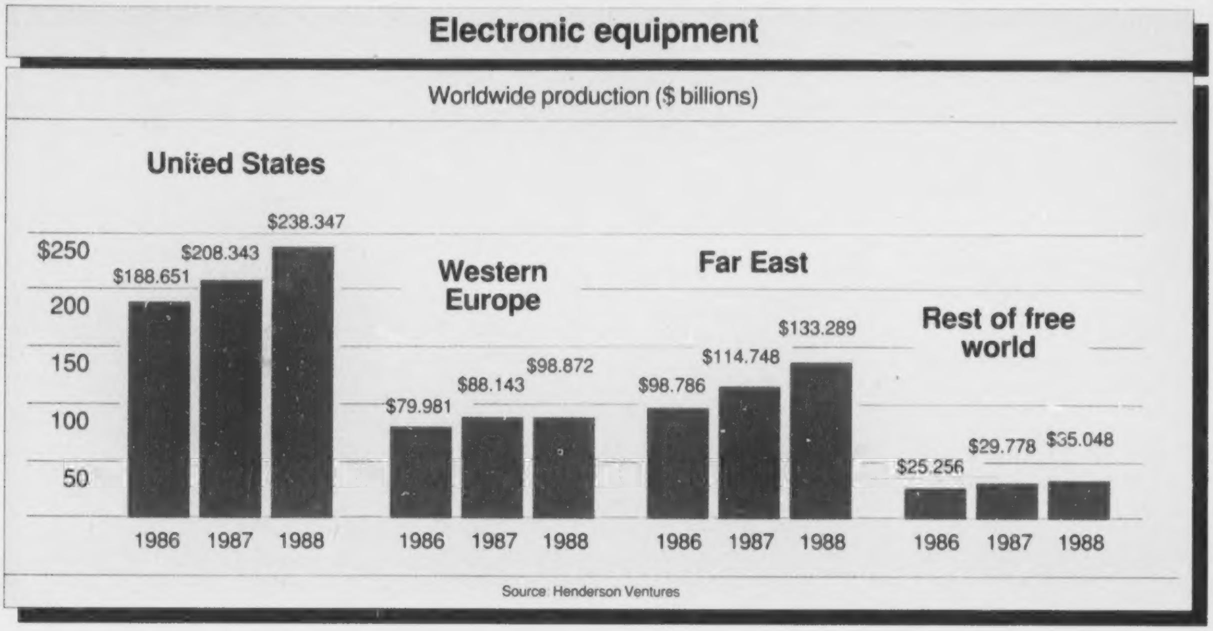
Optimists contend that perspective is needed in discussing the gains of the Koreans and Taiwanese. They are simply not (economically speaking) as important as the Japanese and Europeans. Imports from the Pacific Rim nations represent just 14% of total U.S. imports. But imports from Japan and Europe — whose currencies have appreciated substantially in relation to the dollar — represent almost 40% of our whopping import bill. Already, says DRI, U.S. exporters are capitalizing on the currency situation in Europe. U.S. exports to the European Economic Community rose by 10.8% in the first seven months of 1986.

DRI's Wyss observes that it could be a mistake to write off the importance of currency shifts because the trade balance has not yet shown substantive response. "The history of the trade deficit has been that it tends to move later than people think. But when it does move, it moves very quickly." DRI expects the deficit to begin narrowing in 1987: down from last year's estimated $151 billion to a projected $133 billion.

The turning point

Peter Fousek, executive vice president and director of research for the Federal Reserve Bank of New York, watches trade trends closely. He sees early-bird signs of improvement in such sectors as lumber, chemicals and pharmaceuticals. "I think the turning point is here," Fousek told assembled economists at the Conference Board (a nonprofit business research firm) meeting.

Reading the fine-lined tea leaves of trade is one thing. Acting wisely to capitalize on the trade situation is another. Many observers are concerned that U.S. firms will sacrifice potential long-term competitive gains for easy short-term profits. The Fed's Fousek, for example, found it "disturbing that domestic manufacturers are increasing prices." The point is that American manufacturers in electronics and other industries have an extraordinary opportunity to regain both domestic and international market share. But they must capitalize on the pricing problems of the Japanese to build presence in new markets and regain authority in old ones. In many sectors of the world, notes Elliot



Electronic equipment

Worldwide production ($ billions)

Source: Henderson Ventures

Riordan, manager of international consulting for Wharton Econometric Forecasting Associates, the competitive strength of the Japanese has shown significant deterioration. In Latin America and Australia, for example, currency and economic conditions favor a U.S. export offensive. "U.S. exporters should be very favorably positioned in Latin America," he adds, claiming that a recovering Brazil would prove an especially fertile area for U.S. exporters.

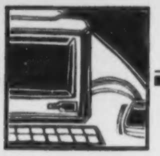
Henderson is convinced that trade will help catalyze economic expansion. "I think the net export situation should turn the economy around in 1987." Asked if this would include an improvement in the bilateral electronics trade deficit with Japan ($9.9 billion for the first six months of 1986, according to the American Electronics Association), Henderson replied: "Yes, I do foresee an improvement in the balance of trade with Japan." Indeed, with the Japanese themselves building production capability in the United States, he predicts a rather remarkable turn of events. By 1988, he says, the rate of growth in U.S. electronic equipment production "will probably exceed" the rate of growth of electronic equipment production in Japan.

Henderson also sees rekindled demand in domestic equipment and component markets. "I think there is the start of pent-up demand and kind of a desire to start kicking the tires on the new equipment." Crisper demand for equipment would translate into order momentum for component manufacturers. Lean inventories should also help. Last year, Henderson calculates, equipment makers were able to take $511 million of components out of their own inventories. This inventory drawdown actually represented almost 6% of total component usage. This year, says Henderson, OEM component inventories are "down to pretty much bare bones." He estimates inventories at 18 weeks; well below "normal" levels of 27 weeks. Thus, even if makers of computers, instruments and communications gear sell no more equipment than they did last year, their purchases of components should rise by 6%. Since Henderson expects U.S. equipment sales to rise by 14%, semiconductor consumption is expected to rise by 22%. Dataquest Inc. sees somewhat slower growth for electronic equipment — 11% for North America — and expects that North American semiconductor consumption will expand by 12% to $11.45 billion.

Too much optimism?

If optimism in today's economic environment seems unwarranted, think back a few years. The world economy was then hostage to an oil cartel that had raised the price of the industrial lifeblood by more than 800% in a decade. If you (and your bankers) had enough faith in your business to expand it, you could access capital at a prime rate running somewhere between 15% and 20%. The real value of profits was eroding at the rate of inflation: about 12% to 13% a year. And the Federal Reserve was so alarmed that it was willing (and able) to induce recession just to choke off inflation. With a yen/dollar equation of 230:1, it was U.S. manufacturers (and not, as is now the case, Japanese manufacturers) that were skimping on long-term investment and squeezing profits to adjust to pricing pressures.

Today, inflation has been subdued to its most temperate pace in 20 years. Money costs half of what it did. Oil costs even less. It is remarkable, really, that so many frightfully damaging and dangerous economic conditions have been reversed in the last two or three years. Sure, there is enduring cause for concern over budget and trade deficits each exceeding $150 billion. Sure, the tax bill will discourage some investment and the consumer may begin to notice he owes next year's wages. These are serious issues. But the truth is that the economy can never be squeezed into some ideal platonic form. It will always bulge or leak somewhere. That's why economists always have something to worry about. This may be one year, though, that it's worth looking beyond those worries. It's what economists have stopped worrying about that is really revealing. ☐



Computers: New names, new chips and $50.5 billion sales

The computer industry should show some modest growth in 1987. The technical segment will be the star performer

By Anne Knowles

The year of the 386. IBM's make-it-or-break-it year. The year of Unisys. A decade from now, 1987 may be remembered by the computer industry for any number of things, ranging from computers based on Intel Corp.'s 32-bit, 80386 microprocessor — commonly called the 386 — to newly formed Unisys Corp., the result of the merger of Burroughs Corp. and Sperry Corp.

The coming year will not be remembered as a year of phenomenal growth, though. In fact, according to most analysts, slower and more predictable expansion in the computer industry is here to stay. Stabilization started last year when computer shipments rose approximately 10%, according to market research firm International Data Corp., in Framingham, Mass. This year, predicts Dataquest Inc. of San Jose, Calif., the U.S. computer market will increase at about the same rate, from $46.2 billion to $50.5 billion. And IDC projects that computer shipments will continue to grow 10% annually for the remainder of the decade.

But some segments of the computer market are more equal than others. Sales of computers for technical applications — including computer-aided design and engineering, scientific research, and industrial automation — should remain robust, jumping 25% annually through 1990, says Hal Feeney, director of technical computer systems at Dataquest.

Meanwhile, 1987 revenue for computers shipped into business applications should rise only 4.7%, from $19.1 billion to $20 billion, says Van Weathers, Dataquest's director of business computer systems. That classification, says Weathers, includes systems spanning from mainframes to multiusers workstations, capable of handling two to 11 users.

Within that group, some size systems will fare better than other. Sales of corporate resource computers, or mainframes, will be nearly flat, hobbling up 1.5% from $6.7 billion to $6.8 billion, and their average selling price, predicts Weathers, will remain $3.5 million. What Dataquest calls a workgroup computer, equipped for two to [illegible] users, on the other hand, will [illegible] 5.9% sales growth, from $3.6 billion to $3.8 billion. The average price of such a system, however, should drop 4.3%, from $18,400 to $17,600. "One of the factors that is certain to emerge in 1987 is systems based on Intel's 80386," says Weathers. Part of the reason for this, says Weathers, "will be vastly increased memory and throughput, and decreased prices for workgroups. They [80386-based systems] will have prices significantly lower than minicomputers with the same functionality."

> Sales of computers for technical applications should remain robust

Systems based on the 386 had already been announced in 1986 — most notably from clone leader COMPAQ Computer Corp. and original equipment manufacturer (OEM) supplier, Convergent Technologies Corp.

A 386 boost

Many participants are looking to the 386 to give the computer industry a much-needed morale boost in an otherwise tepid year. Convergent, in particular, is hoping its NGEN Series 386 will rejuvenate the company. After a year of both OEM and management defections, Paul Ely, Convergent's chairman, expects the 386 to have "a dramatic effect," on the company. "We have never introduced a product that has had broader or more universal acceptance," says Ely. Virtually all of Convergent's 200 customers, notes Ely, are supporting the NGEN Series 386.

This means a spate of 386-based product announcements in 1987, including an introduction by Convergent's largest OEM, Unisys. But the 386-based machine that the industry most anxiously awaits is Big Blue's. Many observers, including Ely, expect that IBM will also announce a proprietary operating system with its 386-based computer. But that doesn't worry Ely. Even IBM, says Ely, cannot afford to turn its back on the 50,000 application packages written for MS-DOS, the operating system developed by Microsoft that runs on IBM's PC XT and PC AT. What IBM will do, Ely anticipates, is offer its new system with an MS-DOS interface, similiar in purpose to Convergent's MS-DOS interface on its propietary operating system, CTOS. "That will be helpful to Convergent," says Ely. IBM's approach, he contends, "will legitimize all the alternatives provided by other vendors."

It is still anyone's guess when IBM will make its 386-based product announcement. Dataquest's Weathers believes that it will not happen until at least the fall of this year and perhaps as late as 1988. Ken Bosomworth, president of International Resource Development Inc. in Norwalk, Conn., thinks that IBM will show its hand sooner. In any event, says Bosomworth, if IBM does not reveal its cards by May, it may be too late for Japanese and Korean clone makers to duplicate compatible machines before the year-end. But one Korean clone maker, Goldstar, jumped into the foray feet first when it announced a 386-based machine last November.

Analysts are also expecting a lot of action at the other end of the computer spectrum. The supercomputer market, for example, shows no sign of a slowdown. Jeffry Canin, a senior analyst with Hambrecht & Quist Inc. in San Francisco, says shipment revenue will increase about 30% to $750 million in 1987. By 1990, Canin projects that supercomputers will be a $1.5 billion business.

Last year, 70 supercomputers were shipped. About half were Cray Research Inc.'s machines, seven were Cyber 205s, shipped by ETA Systems (formerly the supercomputer division of Control Data Corp.), and the remaining systems were sold by three Japanese manufacturers, Fujitsu, Hitachi and NEC. For 1987, Dataquest's Feeney points out that Cray's systems have already sold out, these systems having delivery lead times of up to a year.

While Cray will remain the dominant player, with 65% market share, Canin says that Fujitsu will eclipse ETA's second-place status inherited from CDC. But, despite inroads made elsewhere, Japanese manufacturers are still having trouble selling into the larger U.S. market. Part of their dilemma, says Canin, is that the U.S. government, which represents about 40% of Cray's business, is reluctant to buy from a non-American manufacturer. Another problem is that the Japanese makers underestimated the importance of application software and overestimated the desire for IBM-compatible machines in the supercomputer market.

A minisuper heat-up

The market for so-called minisupercomputers is also heating up. At the end of 1986, there were 450 minisuper systems installed worldwide and over one-third of these had been installed in that year, says Canin. But a few minisuper makers may have to avoid the heat by getting out of the kitchen. Already, says Canin, there is deep discounting going on in the three-year-old market. Cray, in contrast, has been shipping supercomputers for over a decade and has never had to discount a system to make a sale. The result, says Canin, will be a shakeout in the minisuper market leaving two or three start-ups out of about a dozen, left to compete.

And the competition will eventually be dominated by DEC and IBM. The discounting occurring now, says Canin, is due to competition from DEC. The Maynard, Mass., mini maker is offering steep discounts on its high-end VAX line, says Canin, to win contracts that the minisuper upstarts are targeting, too.

Business computers

U.S. market ($ billions)

System	1986	1987
Workgroup (2–10 users)	$3.60	$3.81
Small department (11–20 users)	3.06	3.30
Large department (21–64 users)	2.77	2.96
Business unit (65–149 users)	2.88	3.10
Corporate resource (150+ users)	6.75	6.85
Total	**$19.06**	**$20.02**

Source: Dataquest Inc.

DEC is expected to make another response to the minisuper threat this year. Canin believes DEC will announce a high-end system with vector processing capability. Vector processing, found in Cray supercomputers and minisupers from Alliant Computer Systems Corp. and Convex Computer Systems Corp., enables a computer to work on matrices of number, rather than sequences of numbers. DEC's system, predicts Canin, will not be available for delivery until 1988.

IBM's answer to all of this, so far, has been to offer a vector processing add-on to its mainframe series. The add-on is competitive if a customer already owns an IBM mainframe. But if both, a vector processor, priced at $350,000, and a mainframe, priced upwards of $1 million, must be purchased, then IBM will have a tough time competing with minisupers, which average between $500,000 and $700,000.

Casey Powell, president of minisuper start-up Sequent Computer Corp. in Beaverton, Ore., sees a lot more going on in 1987 than a few product announcements. "We're going through some fundamental changes in the computer industry," says Powell. He believes that computer architectures are evolving from single processor configurations to multiple processor-based machines and they are either being utilized as multiprocessors (numerous processors running numerous, separate programs) or parallel processors (numerous processors running pieces of the same program in parallel time). As an example of this trend, Powell cites DEC's current high-end VAX 8800, which has two processors, and Data General Corp.'s top-of-the-line MV 20000, also a dual processor machine.

Whether Powell is right remains to be seen. But DEC, DG and IBM have more immediate concerns. DG, after a year of lackluster sales and a costly court settlement with Fairchild Semiconductor, "has to try desperately to bounce back," says IRD's Bosomworth.

Meanwhile, IBM is trying to cut costs through attrition and reduced spending in an effort to improve its pruned profits, which dropped 27% in the third quarter of 1986. At the same time, Big Blue has to be wary of the army of 386-based clones, while trying to counteract DEC's dominance in the mid-range market. IBM's 9370 minicomputer, announced last October and expected to ship by the end of 1987, is reportedly compatible with IBM's mainframes.

DEC, on the other hand, with a product line that was rejuvenated throughout 1986, will try to maintain its earnings momentum. But all manufacturers, including DEC — which does about 30% of its business outside the United States — will have to deal with an expected slowdown in European markets. Concludes IRD's Bosomworth: "DEC is on such a roll and the competition between DEC and IBM will be so fierce that DG may get left in the dust."

Most analysts agree that the potential threat of Unisys' won't be felt until at least 1988. "It will take awhile to consolidate their [Burroughs and Sperry] organizations and move both groups in the same direction," says Dataquest's Weathers.

Sequent's Powell predicts more deals in 1987. "I think its going to be another year of severe testing, consolidation and weeding out," says Powell. Weathers agrees. He expects continued mergers and acquisitions by companies "with substantial market share." But, Weathers warns, such megadeals are unpredictable. ☐

Peripherals: Heated action in an attached business

Manufacturers are having to adjust to slower growth and competition that just won't go away. More turbulence ahead

By John Kerr

In 1987, one element computer-peripherals makers will not lack is competition. They would prefer stronger demand and better profit margins. But with the inebriating growth rates of the computer revolution now history, they must settle for more sober increases in demand averaging 15% to 20% annually.

Confirms John Sasso, president of terminals maker Esprit Systems Inc. of Melville, N.Y.: "We're expecting to see continued improved growth, but nothing explosive. Now that most of us have got our inventories down, companies are healthier. The difficult times have made us all stronger."

Most maybe, but not all. Recovery is patchy: while some peripherals players are on a runner's high, plenty of others are wheezing behind. Ten disk-drive makers threw in the towel in the past year. Others exited the terminals sector. Several enhancement-board makers are hurting. That the pressure is still on is seen in faltering earnings by makers of everything from tape drives to printers.

For the most part, peripherals manufacturers begin 1987 a little wiser and considerably more careful. "Everybody got burned so badly in 1985 that there's a little Missouri [caution] in all of us," says Dan H. Wilkie, president of disk drive- and computer-maker Tandon Corp. of Chatsworth, Calif.

Wisdom, for drive makers like Maxtor Corp. of San Jose, Calif., means dedication only to the high-performance, high-capacity end of its markets where competition is cooler and margins remain respectable. For others like modem builder Novation Inc. of Chatsworth, Calif., it means escaping the fray by diving into niche markets such as fold-up boards for portable computers.

And for many, it translates into going where the action is — while it is still active. Producers of disk drives and modems alike have decided that personal computers (PCs) are where it's at. They are riding not so much on a tidal wave of demand for IBM's hot-shot PC AT desktop as on surging demand for clones the AT has spawned. Most of the rush is coming from add-on business, not from original-equipment manufacturer markets.

> For the most part, peripherals makers begin 1987 a little wiser and considerably more careful

Some question the wisdom of catching PC clone fever: "If I were competing in the 20- to 30-megabyte PC AT marketplace, I would wonder how much longer that market could continue to grow," says Skip Kilsdonk, Maxtor's marketing director.

The peripherals industry's new mood of realism is apparent in the terminals arena. "We've gone from a period of very high growth rates to a more mature phase," says Gregory W. Blatnik, associate director of the display terminals industry service of San Jose market research firm Dataquest Inc. Esprit's Sasso predicts 15% annual growth at best, much of it from add-on business.

Dataquest expects pricing slides to continue: for 1986 shipments by U.S. independent terminals manufacturers totaled 853,000 units worth $663 million. By the end of the decade, the units will be up — 1,425,000 — but the dollars down, at $566 million. So real dollar growth means growing market share.

Market leader Wyse Technology of San Jose plans to do that by offering more features — higher-resolution screens, more keyboard functions. Esprit aims to provide shinier after-sales service, and claims the strategy is working: gross margins are around 34% — a year ago they knelt nearer 27%.

In disk drives, the theme is that business is still no picnic. "The disk-drive industry is a very tough place to exist unless your product line is kept up to date, *and* you are a low-cost

Hard disk drive market

Worldwide revenue ($ millions)

	1985	1986	1987	1988	1989
Cartridges, packs	$938	$775	$654	$517	$411
Less than 30 MB	1,863	2,075	2,265	2,739	3,215
30 to 100 MB	1,279	1,909	2,098	2,157	2,128
100 to 300 MB	1,106	1,118	1,447	1,691	1,837
300 to 500 MB	1,332	1,293	1,795	2,112	2,285
More than 500 MB	7,199	7,880	10,454	13,931	15,772
Total revenue	**$13,717**	**$15,050**	**$18,713**	**$23,147**	**$25,648**

Source: Disk/Trend Inc.

producer, *and* you attain a major market share, *and* your management thinks clearly and works long days," says the latest report from market researcher Disk/Trend Inc. of Los Altos, Calif.

According to Disk/Trend vice president Robert Katzive, rigid-drive growth will continue, picking up from 1986's slump to spin at a compound annual average rate of 19.6% from 1987 to 1989. High-end 5.25-inch sectors will show up best as demand steps up from 30- to 100-megabyte units to 100 to 300 megabytes.

Does that mean any relief from intense pricing pressure? "I'd like to say 'no,' but I don't see it" says Chet Baffa, sales and marketing vice president at Micropolis Corp. in Chatsworth, Calif. Tandon's Wilkie adds that a unit price swing of $5 is reason enough for a customer to take a contract from one supplier and give it to another. "The survivor in this business is the low-cost producer," he says.

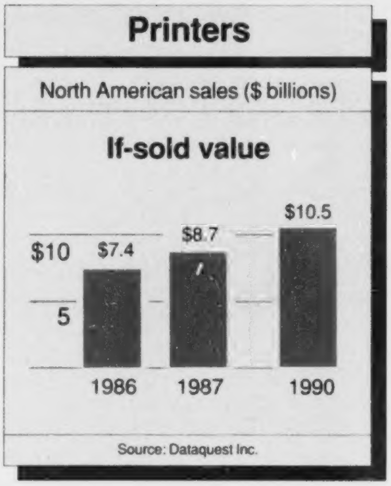
Among the lords of low cost are Seagate Technology in Scotts Valley, Calif., and turnaround Miniscribe Corp. of Longmont, Colo., which not long ago was in serious trouble. "If you're not a Seagate or a Miniscribe with those kinds of volumes, it's going to be tough," warns Katzive.

Tandon's high-volume hustle is in little 3.5-inch Winchester drives of 10- to 30-megabyte capacity, which it builds at up to 40,000 a month. They will help Tandon toward the 15% to 20% "up" year Wilkie anticipates in 1987.

Others expect good results too. Micropolis doubled in 1986 from a $95 million company in 1985, and expects strong sales throughout 1987 as demand from PC users pulls along its 50- to 85-megabyte drives.

Micropolis is one of those tilting toward the market's top end; this year its new 380-megabyte drive comes on stream. Maxtor's focus is higher still: marketing director Kilsdonk expects his new 760-megabyte 5.25-inch Winchester to be in pilot production by early February, and to form the basis of one of the first 1-gigabyte 5.25-inch units. He predicts that Maxtor's 1987 sales could be 30% better than 1986.

Emphasis away from mainframes and minis toward desktop computers has throttled back orders for tape-drive makers, according to Thomas Makmann, marketing vice president at Archive Corp. in Costa Mesa, Calif. Typically, demand is notching up at 15% to 20% annual rates compared to nearly double that in previous years.


Printers

North American sales ($ billions)

If-sold value

Source: Dataquest Inc.

This is disappointing some players: citing increased competition and squeezed margins, Cipher Data Products Inc. of San Diego is closing down a California plant as it moves more of its production to Singapore.

Market analysts also say 1987 should be the year that optical memory drives get noticed. Compact-disc types that can only be "read" will be most prominent, but write-once, read-many drives will begin to show up in practical applications.

> Laser printers are steadily climbing the price-performance ramp

A state of siege

Printer business remains under siege throughout. Japan Inc. owns four-fifths of the U.S. market for low-end printers — that is, page printers capable of up to 10 pages a minute, and all serial printers. And the top end, where manufacturers like Printronix Inc. of Irvine, Calif., sell to mini and mainframe markets, is flat.

That has not stopped growth dead. Robert Fennell, senior industry analyst for Dataquest's printer industry service, reports that for the printer market overall, revenue will grow at 12% compounded through 1990, and at 14% in unit terms, indicating that price erosion is slackening. He forecasts price-performance improvements averaging 20% to 30% a year.

Fennell sees no easing of competitive pressures nor of profit margins during 1987. The market-share challenge will not be won by technology, he claims, but by those commanding the distribution channels.

A wide distribution net, he notes, is how Hewlett-Packard Co. of Palo Alto, Calif., spooned up the bulk of the market for what could be called "Product Pet of the Year": the low-cost laser printer.

Unveiled in 1984, Hewlett-Packard's laser printer opened up the floodgates for what is one of few bright spots for U.S. printer makers. According to Charles R. Cortright, product marketing director of the systems group at one aggressive competitor, AST Research Inc. of Irvine, Calif., the midrange laser printer business is expanding at over 40% annually.

Laser printers appeal to desktop computer users because they offer letter-quality output, quiet, speed and often graphics capability. They are steadily climbing the price-performance ramp: today's units handling six pages per minute and retailing for about $2,000 will soon crank out 20 pages per minute for little more cost.

The explosion in business use of big PCs also accounts for the 25% annual growth projected by another bullish breed: modem makers. Peter Field, marketing vice president at market leader Hayes Microcomputer Products Inc. of Norcross, Ga., adds a corollary: "The penetration of modems into those PCs is also growing," he says.

Contestants for second place, like Novation and Anchor Automation Inc. of Van Nuys, Calif., charge that Hayes prices as high as it likes because it enjoys terrific name recognition. The runners-up maintain that this policy will be forced to change as pricing pressure climbs.

Novation and Anchor hope to maintain strained gross margins by getting a jump on the shifts in demand from modems that transmit data at 300 baud, or bits per second, to 1,200-baud units and above. "There is a lot of upgrading to 2,400-baud going on," comments Jerry A. Henricks, Novation vice president of sales and marketing.

Like nearly every other peripherals sector, the modem arena remains bloody. "It's [a question of] who's going to get the business, and at what margins. But it's always more fun competing in a growing market than in a shrinking market," says Anchor chairman George Eisler. ☐

An uncertain future for U.S. chip makers

Market forecasts vary somewhat, but no one expects a turnaround soon in the volatile U.S. semiconductor market

By Beth Karlin

While there is no real consensus on the semiconductor industry's performance for 1987 and beyond, one thing is certain: The shakeout has begun, and from now on it's survival of the fittest. "There will be a lot of blood spilled, and of companies scrambling to the safety of niche markets," says Robert N. Noyce, vice chairman of Intel Corp. "But those that remain standing will be the stronger because of it."

Projections for growth vary. Worldwide consumption rose an estimated 23.4% to $30.64 billion (in constant U.S. dollars) in 1986 and will increase 17.7% to $36.08 billion in 1987 and 27.1% in 1988, according to Dataquest Inc., the San Jose, Calif., marketing company. Overcapacity, predicts Dataquest, will lead to a 1.3% decline in consumption for 1989. "The market environment for the industry as a whole is real tough," says Jon E. Cornell, head of semiconductor operations for Harris Corp., Melbourne, Fla. Cornell contends that his company is faring better than some of the others because of its concentration on government and noncommodity niche products.

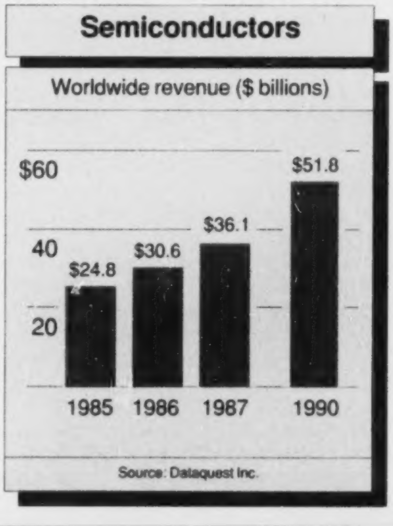
North America experienced the slowest growth. U.S. solid-state component shipments, for example, were expected to increase only 7% in 1986 to $8.65 billion, from $8.09 billion in 1985, according to the Semiconductor Industry Association (SIA). Distributor shipments increased 28.6% for the year, while original equipment manufacturer shipments increased only 1.2%. In 1987, the SIA projects that U.S. shipments will grow 21.7% to $10.5 billion. European shipments, meanwhile, increased 17.8% in 1986, and Japanese shipments jumped almost 40%, according to the SIA.

Clouding the picture, however, is the impact of fluctuating exchange rates. When 1984 exchange rates are used, for example, actual growth in Japan dropped from 40% to 1.2% for 1986 and European growth drops to 0.7% for the year. Averaged together, real growth in the U.S. and other international markets was 7% in 1986, according to SIA. "We hoped 1986 would be a recovery from the worst year in the semiconductor business," says Cornell. "But 7% real growth is hardly a recovery."

Ailing Japan

Japan is suffering as much as — or perhaps even more than — the U.S. semiconductor companies. In addition to sluggish worldwide demand, both the strength of the yen to the dollar and the floor prices dictated by the U.S.-Japan trade accord are cutting into profits. Until recently, Japan's share of the world market was slightly less than 40% and U.S. merchant semiconductor companies had almost 50%. But Japan has since increased its presence, while the U.S. merchants' share has fallen somewhat.

For the next five or six years, says Robert E. McGeary, director of semiconductor equipment and materials service for Dataquest, "market shares [measured in U.S. dollars] will flip-flop back and forth." In unit sales, Japanese and U.S. merchant companies will stay within 5% of each other, with the United States still ahead.


Semiconductors

Worldwide revenue ($ billions)

Source: Dataquest Inc.

Increasingly, Japanese companies are building U.S. fabrication facilities. Hitachi America Ltd. has established a new plant in Texas, and Sharp Electronics Corp., Mitsubishi and NEC Corp. are planning to expand in the United States. By manufacturing locally, Japanese suppliers can get around antidumping regulations, reduce the impact of currency fluctuations, and meet growing demand for popular application-specific integrated circuits.

Korea, meanwhile, is expanding its domestic semiconductor capacity with hopes of becoming a major international player. "Korea is spending prodigious amounts of money on very modern equipment," says McGeary.

Cutbacks

Faced with an uncertain future, companies are cutting back. In October, for example, Harris laid off 500 semiconductor workers, 10% of its international workforce. The same month, Advanced Micro Devices Inc. (AMD), Sunnyvale, Calif., rescinded its formal no-layoff policy and reduced its 12,800-employee worldwide workforce by 500. "No significant indications of improvement in demand have emerged, and our expectations near term are for only modest industry growth," says W.J. Sanders III, AMD chairman.

Semiconductor makers are hoping prices will stabilize after more than a year of price wars for many products. In April 1986, for example, the average selling price of complementary metal-oxide semiconductor (CMOS) memories was 28% lower than a year earlier, according to the Integrated Circuit Engineering Corp., Scottsdale, Ariz. "Pricing for most products has recovered pretty well," says an AMD spokesman.

In some cases, memory buyers complained that prices were too high — as a result of the U.S.-Japan trade accord on dynamic-random access memories (RAMs) and erasable programmable read-only memories (EPROMs) in August. After that agreement, Japanese manufacturers and U.S. semiconductor companies that make products in Japan scurried to re-adjust their prices to the dictated fair market value (FMV) floor prices. Computer makers in particular claimed that the DRAM prices were artificially inflated.

> "It would be ludicrous for anyone to suggest that we can go back to the way things were during the infancy of our industry"
>
> Robert Noyce of Intel

A new round of FMV came out in October, and the U.S. Trade Representative's Office argued that pricing would stabilize at a competitive level. Besides, says U.S. Trade Representative Clayton Yeutter. "There is no consumer of semiconductors or any other product who is entitled to insist on dumped prices." Yeutter also reacted to critics who called the FMVs a price umbrella. "The talk of a price cartel . . . is just sheer, unadulterated nonsense," he says. "Not one word of this agreement established price."

Although semiconductor makers are optimistic that the chip business will once again become a healthy business, they do not expect it to be as robust as it was in the early years. "It would be ludicrous for anyone to suggest that we can go back to the way things were during the infancy of our industry," says Noyce. "Things changed quickly then, and new technology was enough to assure a profit. Those days are over."

Noyce believes, however, that the problems facing the industry can be solved. By 1991, he predicts, the domestic semiconductor industry will once again be strong. "Now that the battle flag has been raised," says Noyce, "I think we'll finally start to see some results." ☐

EXECUTIVE RECRUITMENT

1987 Executive Recruitment Editorial Calendar

Issue Date	*deadline*	*Special Features*	*Management Strategies/Analysis*	*Bonus Distribution at Trade Shows*
February 1	Jan. 12	Top Superminicomputer Companies	Materials Handling	
February 15	Jan. 23	CIM	Electronics Factory of Future	Nepcon West 2/24-26
March 1	Feb. 9	Top Semiconductor Companies	CEPS	Ceps V 3/3-5 Semicon Europa 3/10-12
March 15	Feb. 23	Top Engineering Workstation Cos.	University Parks	NCGA 3/22-26 Southcon 3/24-26 ADEE 3/31-4/2
April 1	March 9	Best Executives	Power Supplies	Electro 4/7-9
April 15	March 23	Fastest Growing Companies	Military Electronics	
May 1	April 9	Computers	CMOS ICS	Canadian Hi-Tech 5/5-6 EDS 5/13-15
May 15	April 23	Semiconductor Production	Top Venture Capital Firms	Semicon West 5/18-21
June 1	May 11	Top Computer Companies	Distribution	Nepcon East 6/9-11
June 15	May 25	Top CAE Companies	ATE	ATE East 6/23-25 NCC 6/15-18
July 1	June 9	1987 Midyear Forecast Update	Artificial Intelligence	
July 15	June 23	*Electronic Business 200*	Military Electronics	Siggraph 7/27-31
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OUTLOOK '87

CAE/CAD/CAM: Continued sluggishness in the industry

Efforts by customers to freeze capital spending on CAD/CAM gear and continuing price erosion could slow domestic sales

By Alden M. Hayashi

Unless frozen customer budgets begin thawing, 1987 will be another disappointing year for the CAE/CAD/CAM industry. Product price erosion will continue to eat into market revenue, some analysts also suggest, as sales in foreign markets may level off.

After growing by 56% in 1984, the CAE/CAD/CAM (computer-aided engineering/design/manufacturing) industry continued losing speed last year. Reaching sales of $4.09 billion, the industry could grow by only 14.1%, according to Daratech Inc., a market research firm located in Cambridge, Mass. Daratech says this year could be even worse. "I'm not very bullish on 1987," says Charles M. Foundyller, Daratech president. Foundyller is predicting a growth of just 11%.

Many of the CAE/CAD/CAM vendors claim 11% is too pessimistic. However, no one is betting on a recovery anytime soon. "We expect to see growth in the market but we expect it to be moderate," says Robert Moore, marketing director for Daisy Systems Corp. of Mountain View, Calif. Adds Thomas H. Bruggere, president of Mentor Graphics Corp. of Beaverton, Ore.: "We feel pretty good about next year but we're not assuming any big turnaround."

Uncertainty concerning customer budgets has capped the industry's optimism. Reportedly, customers have budgeted, but not yet spent, hundreds of millions of dollars for CAE/CAD/CAM equipment. For electronics CAE alone, The Technology Research Group Inc. of Boston estimates that U.S. customers last summer had a combined budgetary surplus of more than $500 million.

Whether or not this money will be spent this year is highly questionable. CAE/CAD/CAM systems are costly purchases, and customers lately have been reluctant to part with their money. The slump in the general electronics industry, historically a major customer of CAE/CAD/CAM equipment, has not helped. Currently the CAE/CAD/CAM industry, particularly in the electronics segment, suffers from a syndrome of too pricey products chasing too poor customers.

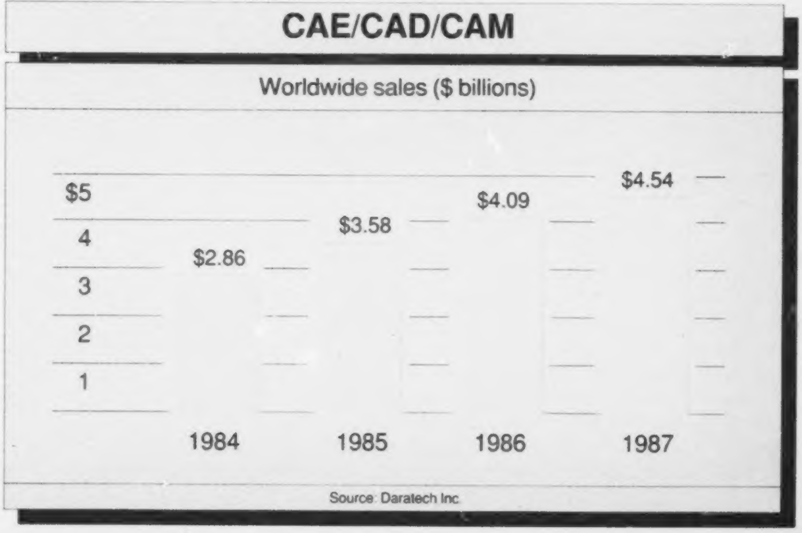
Pressure to automate

Regardless, the pressure for customers to automate and buy CAE/CAD/CAM equipment soon may become unbearable, says Robert A. Fischer, in charge of the CAD/CAM and workstations group for Prime Computer Inc. of Natick, Mass. "To maintain their competitiveness, customers will have no choice but to take advantage of the tools available. You can cut back on your capital expenditure program for only so long," says Fischer.

Still, customers thus far have managed to refrain from making major purchases. Many vendors had expected that customers would be freeing up budgeted moneys by now [ELECTRONIC BUSINESS July 1, p90]. "It's certainly a lot more sluggish now than I thought it would be a year ago. Many customers have taken a let's-wait-and-see attitude," says John W. Gridley Jr., chief financial officer of Intergraph Corp. of Huntsville, Ala.

And the recent U.S. tax law changes have not really helped the CAE/CAD/CAM industry, adds Gridley. He explains that while the tax law revisions will help spur consumers to buy goods such as automobiles and televisions, they will do little to encourage companies to increase their capital expenditures. "There doesn't seem to be anything there to stimulate any demand for our products," says Gridley.

Unfortunately, a stimulation of demand is just what the market needs right now. Without it, vendors remain unsure as to exactly when customer budgets will begin to free up. "There's more uncertainty now than before and the bottom line is: we really don't know when things will get better," says Gridley. Adds David R. Foster, vice president of marketing for Valid



Source: Daratech Inc

Logic Systems Inc. of San Jose, Calif.: "I really don't know, with the uncertainty in this marketplace, how we can make any educated projections."

But vendors maintain, and market analysts concur, that the frozen budgets do not indicate customer discontent with the CAE/CAD/CAM technology. "On the contrary, the vote of confidence of using CAD/CAM is probably at an all time high," says Daratech's Foundyller.

Some in the industry wonder whether customer budgetary surpluses still exist. "I think the money isn't there anymore. I think companies budget contingent upon their own performance," says Foundyller. He explains that although companies that are doing poorly may not officially readjust and cut their budgets, they will invent other ways to curb spending, for example, by adding more red tape to the purchasing process. "They'll essentially kill the money," says Foundyller. Adds Bardwell Salmon, a vice president of Computervision Corp. of Bedford, Mass.: "The real message is: The money is not going unspent," because it is not there anymore.

CAE/CAD/CAM

1986 worldwide market share

IBM	23.9%
Intergraph	14.8%
Computervision	11.8%
Calma	5.0%
McDonnell Douglas	4.5%
Applicon	4.2%
Mentor	4.2%
Prime	3.4%
Control Data	2.9%
Daisy	2.3%

Total 1986 market
$4.09 billion

Source: Daratech Inc.

Frugal customers

A price erosion in the industry also has slowed industry sales. According to Laura Conigliaro, analyst for Prudential-Bache Securities Inc. of New York City, the price per seat of a CAE/CAD/CAM system has fallen sharply, from upward of $125,000 two years ago to roughly $40,000 currently.

This tremendous price decline mainly has been due to the increasing popularity of the personal computer (PC). Daisy's Moore reports that PC-based products now account for 50% of his company's sales on a dollar basis and 70% on a unit basis. Several years ago, Daisy's systems were based exclusively on more expensive super microcomputer workstations. "There's been tremendous growth in the low end of the market," agrees Intergraph's Gridley. In fact, Computervision's Salmon says that certain PC-based CAD products, such as those automating two-dimensional drafting, rapidly are becoming commodity products. "There are packages out there selling for less than $1,000," he says.

Daratech's Foundyller predicts that the price erosion will continue throughout 1987. He says that while the dollar growth of the industry will be around 15% this year, the unit growth will be closer to 25%. Particularly in these touchy economic times, "people will be reluctant to go for the top-of-the-line systems," says Foundyller. "The price of the units themselves, they're not going to be radically different. But a price erosion will continue to occur in terms of the product mix that customers will buy. Before, a customer might have bought two of System X [a cheap system] and four of System Y [a more expensive system]. Now, they're going to buy four of System X and two of Y."

> Certain PC-based CAD products, such as those automating two-dimensional drafting, rapidly are becoming commodity products

Success overseas?

Yet, while domestic sales have slowed, virtually all of the CAE/CAD/CAM vendors report flourishing business overseas. Daisy's Moore says that international sales accounted for about one-half of his company's total sales last year, up from one-third in 1985.

"We see, in particular, the European market as being strong," says Computervision's Salmon. Indeed, says Kenneth B. Fine, Valid president. Valid's sales in Europe alone have grown from 25% of total sales to about 50% last year, according to Fine. "There's a lot of pent-up demand there," claims Daisy's Moore. He explains that the European CAE market is at least one year behind the U.S. market. Consequently, the fast-growing early-adopter market in Europe has not been saturated yet, as has been the case in the United States.

Europe is not the only foreign market vendors are counting on. Mentor reports that its sales in Japan increased by 50% last year. "The Japanese companies are still hurting but they're still spending," claims Mentor's Bruggere. He estimates that the Japanese market lags the U.S. by two years.

Last year's success in overseas markets will be difficult to maintain this year. Daratech's Foundyller explains that the recent depreciation of the dollar's value was the chief reason behind the success last year of U.S. companies in foreign markets. The dollar's depreciation enabled many companies to report huge increases of foreign sales on a dollar basis when, in fact, those same sales on a foreign currency basis were flat. Foundyller warns that U.S. companies will not have that advantage this year, assuming the dollar doesn't drop further. ☐

Production equipment: Up slightly but still tough going

It will be survival of the fittest for makers of semiconductor production gear in 1987. But brighter days lie ahead in 1988

By Mark Mehler

Semiconductor producers, for the second year in a row, will be able to supply more components than their customers will demand. So it is not surprising that the folks who supply equipment to those producers are braced for another lackluster year.

Worldwide sales of semiconductor production equipment will rise 8% to $5.35 billion in 1987, but expand 33% to $7.2 billion in 1988, predicts VLSI Research Inc. The market research firm figures that equipment makers closed their 1986 books with $4.97 billion in sales, down 20% from the previous year.

"This is clearly the worst sustained recession in the industry's history," says G. Daniel Hutcheson, president of San Jose, California-based VLSI. "Right now, the problem equipment suppliers are having is the booking levels have been so low for so long, with no hard upswing in the near future, that they're having to make major cutbacks in their organizations."

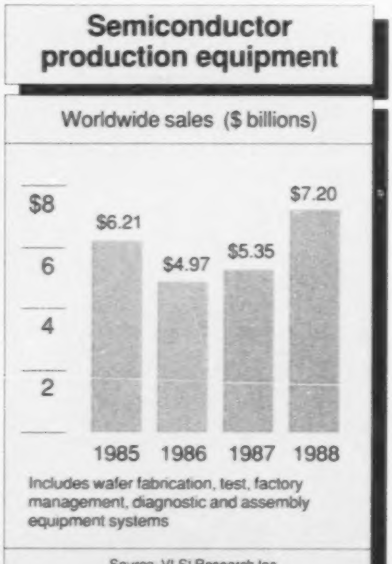
An even more pessimistic view surfaces in a market study by one equipment supplier. The report estimates excess capacity for 1- to 3-micron integrated circuits, representing the bulk of current IC output, reached 20% in the second half of last year. Although the study points to the promise of submicron geometries driving future purchases of advanced equipment, the report predicts the equipment industry will continue to shrink.

No one spared

Despite VLSI Research's rosy prognosis for 1988, even the largest and most heavily capitalized equipment manufacturers have been unable to avoid major surgery.

Eaton Corp., the $3.7 billion conglomerate, last fall discontinued production of its wafer steppers, in-process testers and automatic test equipment. Cleveland-based Eaton, ranked No. 6 in integrated circuit equipment sales just two years ago, cited the need to increase cash flow and concentrate on its mainstream truck parts and defense businesses. Eaton, which sold $185 million worth of IC equipment of all types in 1985, will continue supplying ion beam systems for the IC industry.

Perkin-Elmer Corp., the Norwalk, Connecticut-based market leader, saw semiconductor equipment sales fall about 21% from $330 million to $260 million in the fiscal year that ended last July 31. "This is a time to batten down the hatches," says Charles Minihan, who heads PE's Semiconductor Equipment Group. "For us, that means controlling expenses and allocating R&D [research and development] dollars on a prioritized basis. Lithography [optical and electron-beam exposure systems] is our principal business activity, and that is the area that we will focus on in this climate." Sources indicate that PE plans an exit from its plasma etch and sputter deposition businesses, although Minihan says the company is continuing to seek orders for such machines.


Semiconductor production equipment

Includes wafer fabrication, test, factory management, diagnostic and assembly equipment systems

Source: VLSI Research Inc.

General Signal Corp., the No. 3 supplier with $218 million in 1985 sales of IC equipment, is also pulling in its horns. Company officials last fall acknowledged that its Micro Automation unit, a maker of wafer-dicing saws, is for sale.

Veeco Instruments Inc. is another supplier reportedly questioning the wisdom of offering a broad line of IC equipment. "We need to adjust our levels of expenses and inventories to be [in sync] with the soft market," says B. Alan Ross, general manager of Veeco's Equipment Division, explaining why the Long Island, N.Y., company last fall took a write-down of excess inventory of ion implanters. Since 1984, Veeco has only sold about 10 of the $1.2 million systems, which shoot ions into wafers to give them the desired polarities.

The smaller independent merchant equipment vendors also are scrambling to maintain sufficient volume to ride out 1987 intact. Machine Technology Inc., a maker of photoresist processing systems and other front-end fabrication equipment, elected late last summer to take on another $1 million in long-term debt. Gary Hillman, president of Parsippany, New Jersey-based MTI, believes it will take even more than additional leveraging to survive the recession.

"People talk a lot about the need to reduce manufacturing costs, but ultimately you have to be able to develop products more cheaply, to learn to be a low-cost innovator as well," he argues. Whereas the typical cost of developing a new IC system is roughly

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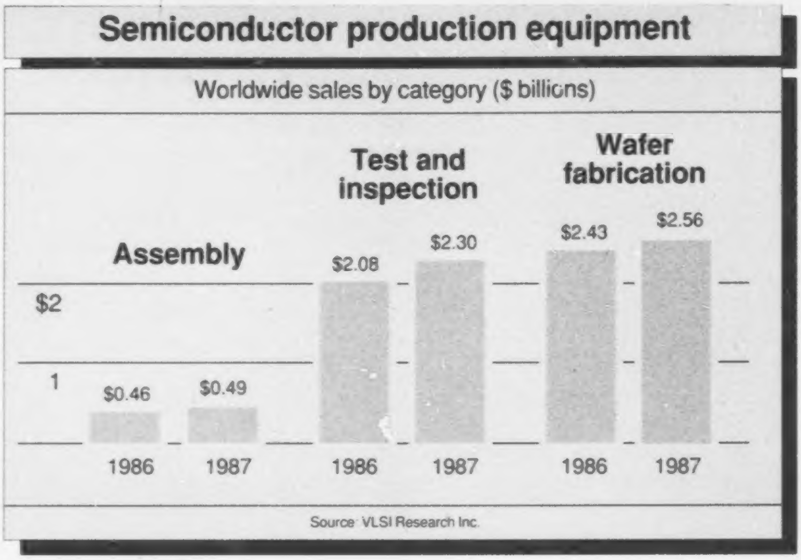

Semiconductor production equipment

Worldwide sales by category ($ billions)

Source: VLSI Research Inc.

10 times the product's selling price, MTI spent only $3.5 million to bring its $1 million sputtering system to market last year, Hillman says.

"Our way of squeezing out the cost of R&D is very messy; a Harvard MBA certainly wouldn't appreciate it," Hillman concludes. "But if you start with the basic premise that our business is the creation of intellectual value, then that's where you husband your resources."

For others, the key survival tool is diversification into related markets. Consilium Inc., a supplier of software modules for computer-integrated manufacturing (CIM) of semiconductors, over the past six months has begun pushing into such new markets as aerospace, chemicals, automotive and genetic engineering. New customers include Boeing Co., Commodore Business Machines Inc. and Westinghouse Electric Corp. "In 1986, about 40% of our [approximately $12 million] business was outside semiconductors," says Consilium's president, Jonathan Golovin. "In 1987 it will be about 50% . . . our [IC] customers are shell-shocked. We have to think about expanding our user base."

Those vendors continuing to express confidence in the silicon-based IC market tend to be suppliers of either automation- or yield-related products. For example, Semi-Gas Systems Inc., a maker of equipment to purge impure gases from the process line, looks for a fairly strong 10% to 15% hike in volume this year. "We're encouraged that our customers are getting strong legislative pressure to clean up their processes," says Andrew Lorenz, president of San Jose, California-based Semi-Gas.

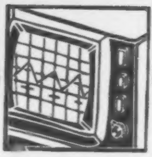
SMT-driven growth

A slightly brighter picture emerges in the printed circuit board (PCB) production equipment market. Universal Instruments Corp., the leader in the $300 million market segment for component insertion and placement equipment, is more optimistic about the coming year.

The cause of Universal's optimism is surface mount technology. SMT, which involves mounting devices on a printed circuit board rather than inserting them through holes, is rapidly driving the equipment business in the direction of flexible (high-mix, low-volume) manufacturing.

"That's what we're gearing up to do — automated, versatile-type production lines," says James Roth, vice president of sales and marketing for Universal. "Our Japanese competitors are not tooled up to handle versatile loads."

The growth of surface mounting will be the No. 1 trend in 1987, agrees Charles Giordanella, vice president of marketing for International Robomation/Intelligence, a Carlsbad, Calif., supplier of vision systems for PCBs. Indeed, he notes, the added emphasis on packaging, as the means of providing more power on a board, is bringing the PCB and semiconductor industries closer together. In this vein, IRI recently introduced a new system to inspect the wire bond of an assembled chip. ☐



Test and measurement: Don't look for any miracles

Instruments and ATE will grow steadily, but there won't be a big turnaround without help from other industries

By David Card

Suppliers of test and measurement (T&M) gear must be asking themselves, "How many more times are we going to hear the line about a second-half recovery?" One more time, anyway.

Last year, the industry grew only 0.3% in sales worldwide, according to Galen Wampler, president of market researcher Prime Data Inc. in San Jose, Calif. But Wampler says fluctuations in currency values exaggerated even that miniscule growth, and that unit sales were actually down. This year, research and development spending will fuel dollar sales to over $7 billion, for a growth rate over 10%, Wampler forecasts.

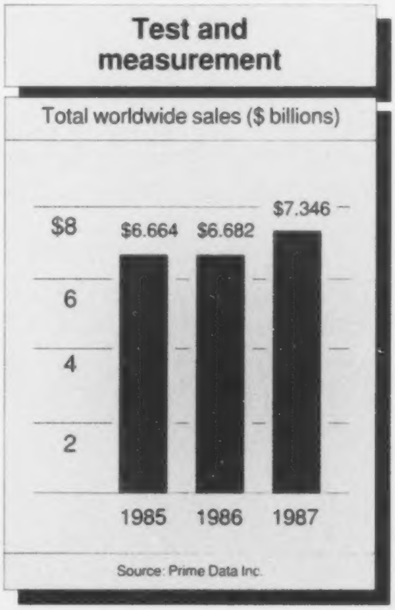
If the general economy is peppy enough, even automatic test equipment (ATE) — which is more dependent on capital spending related to production than to research and development (R&D) — could rebound in the second half of the year, finishing with 8.5% growth, adds Kenneth Neff, who tracks ATE for Prime Data. That would be up dramatically from its 14% drop in 1986, he points out.

Two major customers of test and measurement equipment — computer manufacturers and military/aerospace companies — have curbed their purchases and show no signs of rapidly turning around, Wampler says. Computer makers, which account for some 16% to 18% of test and measurement sales, still seem caught in a slump.

The military/aerospace segment, worth 27% of the market, shows little reason for hope. Wampler sees hardly any sign of strong growth in T&M sales to the U.S. armed forces. And of the aerospace companies Wampler says: "People have been watching their pennies — I should say dollars." Mergers and acquisitions in that industry — and accusations of overcharging — are causing companies to scrutinize their expenses. A Democrat as president in 1988 could darken the defense market considerably, he says.

Along with computer manufacturers, merchant semiconductor companies are a favorite scapegoat for T&M's 1985-1986 woes. "When your factories are running at 60% capacity, you can just about double your sales without adding any capital equipment," says Joseph Keithley, chairman of Keithley Instruments Inc., in reference to the chip companies. Likewise, computer sales would have to rise 20% to 25% to pump up instrument sales, adds Thomas Brick, president of the Cleveland-based Keithley.

> "We certainly see no signs of a massive turnaround"
> Michael Gasparian of Hewlett-Packard



Test and measurement

Total worldwide sales ($ billions)

Source: Prime Data Inc.

"We certainly see no signs of a massive turnaround," says Michael Gasparian, product marketing manager for the Colorado Springs Division of instruments king Hewlett-Packard Co.

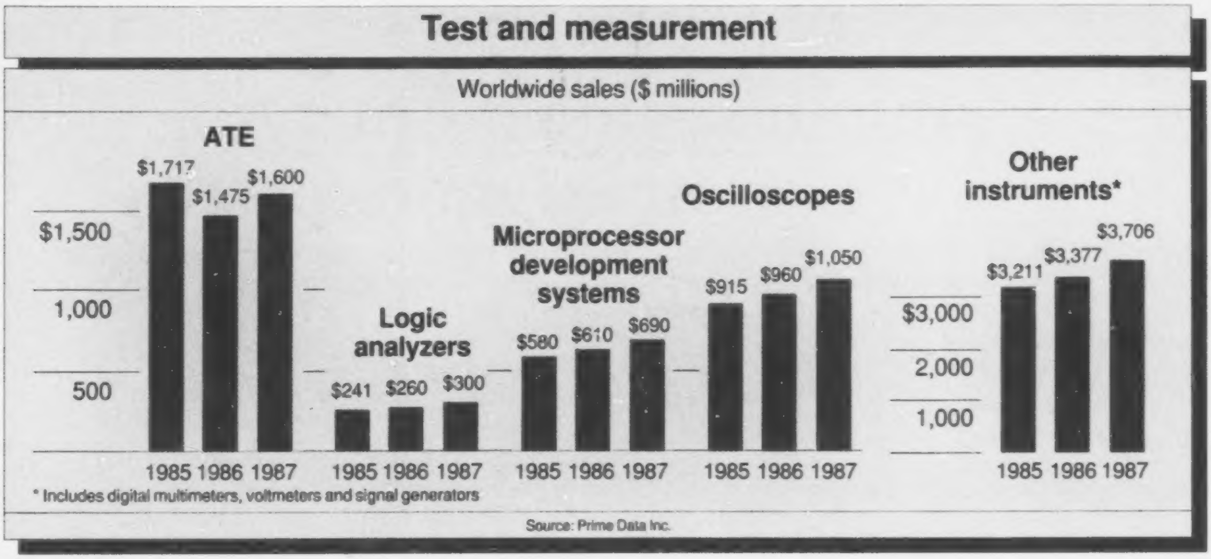
Taxing questions

Industry observers give mixed reviews to the U.S. tax reform bill signed into law by President Reagan last October. Most agree that at least the wondering is over. "The uncertainties are gone, but what replaces them is not positive enough to force purchases for tax reasons," says Prime Data's Wampler. "There is no advantage to buying something sooner, but putting it off is no worse," Wampler concludes. Frederick Bihler, president of the U.S. subsidiary of Japanese ATE and instruments company Advantest Corp., agrees: "It's not good, but at least we know what it is."

Hewlett-Packard's Gasparian is not so sure. He thinks the new tax law has left the electronics industry in a quandary. He reasons that what he describes as an 800-page bill will require some time to decipher. Until companies figure it out, there will be no big instrument purchases.

In oscilloscopes, market leader Tektronix Inc. of Beaverton, Ore., recently introduced its first new line of scopes in 17 years. And wonder of wonders, the line is anchored by a group of modular-design analog scopes. "There is a tremendous amount of activity left in analog," contends Fred Hanson, who heads Tek's Instruments Group. "Contrary to what some might say, there is a lot of life yet."

Those "some" include Hewlett-Packard, which exited the analog scope market about two years ago to concentrate solely on digital. HP's Gasparian claims HP's scopes are selling faster than the market is growing. (Digital scope sales grew 20% last year



* Includes digital multimeters, voltmeters and signal generators

Source: Prime Data Inc.

while analog sales were flat, according to Prime Data. Digital scopes also are generally higher priced than their analog counterparts.)

Nontraditional customers, notably auto makers, have partly fueled HP's fast pace in digital scopes. Gasparian says, of course, that digital scopes offer performance benefits that the newer users are just figuring out. Still, Tek claims — and Wampler confirms — that Tek has the dominant position in digital as well as analog scopes.

Makers of spectrum analyzers, meanwhile, are benefiting from two influences — continued R&D spending by all of their customers and strong capital spending by one of their major customer segments, communications equipment producers. They are also beset by heightened inernational competition.

Marconi Instruments Ltd. of Hertfordshire, England, is seeking to penetrate further the U.S. market from its strong European base, even though it too is under attack. Japanese spectrum analyzers are pouring into European markets, observes Marconi's instruments chief, Sandy Warwick. "Certainly in our business we're more worried about the Japanese than HP is worried about us," Warwick says. "But we're all looking over our shoulders at Japan."

Logic analyzers, used in the design of digital systems, also will continue to benefit from the R&D push, Wampler says. Even though it is the fastest growing of the major instruments segments, competitors are trying to inspire sales. HP has taken to sales gimmicks — the company gives away an ink-jet printer with some sales, and it will soon offer free disk drives.

Tek is positioning its logic analyzer as a front end to a test line-up for application-specific integrated circuits (ASICs), according to Design Automation Group head Tom Long. Tek is jumping on the ASIC bandwagon with its logic analyzer, its new Delta series of instrument modules and its new ATE system. "We don't give a damn which way it goes," Long says, just so ASIC vendors buy some component of Tek's line to exercise their chips.

ASICs, says analyst Neff, have spawned a whole new industry: verification testing. Led by Integrated Measurement Systems Inc. of Beaverton, a flock of start-ups has developed systems poised somewhere between standalone instruments and ATE, to test the prototypes and short production runs of custom chips. Cadic, also of Beaverton, is one such company betting that the start-ups can nimbly stay ahead of Tek and HP, like "thoroughbreds versus dinosaurs," in the words of Cadic president Clifford Yee.

> "There is a tremendous amount of activity left in analog"
>
> Fred Hanson of Tektronix

"Assuming the economy will turn around at midyear," Prime Data's Neff says, "ATE sales will still be below the level they were in 1985." Board test has been hurting longer than chip test, Neff says, but he holds little hope for any pent-up demand to push sales in 1987.

"I wouldn't get too carried away yet," says Craig Pynne, marketing vice president of board tester Zehntel Inc. of Walnut Creek, Calif. He pretty much speaks for the industry when he says he is "gearing the business to sell what we shipped in '86."

In the desperate ATE market, companies have been slashing prices. Pynne says he had to set up a system where his salesmen get a bonus for making a sale at list price. Schlumberger Ltd.'s chip test unit, Sentry, has seen prices drop on its older line of testers — the installed base of which is the industry's largest — to a profit margin-threatening point.

The margins of Sentry's older line benefit from mature technologies, while the new line uses more expensive new technologies but fewer parts. Sentry vice president Fred Laccabue claims his company is nearing the point where the cost of manufacturing both lines is equal. There is one hitch, however. Even though the new line is becoming cheaper to build, it has not caught on in the United States.

Practically the only testers selling in late 1986 were the ultra high-end systems for very large-scale integration (VLSI) chips, Neff says. "People are buying the big testers for their next generation products," he explains. One hotbed of competition, if not volume, was at Intel Corp. Long a Teradyne Inc. customer, Intel has gone with LTX Corp. subsidiary Trillium for the first stage of a potentially huge ATE contract. ☐

Communications: Emerging markets promise more profits

Equipment vendors should dial T-1 multiplexers and fiber optics. PBX and key systems are busy

By Carol Suby

In the never-ending saga of what's hot and what's not in the communications equipment industry, technological advances, regulatory changes and evolving standards are stimulating growth in some equipment segments while ushering in the demise of others.

Overall, the U.S. telecommunications industry — including services and equipment — is expected to grow from $159.4 billion at the end of 1986 to $176.9 billion by the end of 1987, according to market research firm Dataquest Inc. in San Jose, Calif. The equipment portion represents about 14% of the total industry, and growth in this segment is expected to increase from 1986's $22.3 billion to an estimated $24.8 billion during the 1987 calendar year. Areas such as fiber optics and T-1 multiplexers are promising robust growth this year. In addition, integrated circuits (ICs) used in communications equipment continue to provide a ray of sunshine for an otherwise beleaguered semiconductor industry.

Other segments are not expected to fare as well, especially in the area of key telephone systems. This market, which includes feature-rich phones that contain buttons or keys used to select a specific line from several incoming lines, will continue to be fraught with increased competition, pricing pressures and declining profit margins.

Big switch competition

The boom times for central office (CO) switches, the giant machines used by telephone companies to route calls, appear to be over. Nevertheless, a CO-switch market share race is gearing up in the United States, which until now has only included AT&T and Northern Telecom Ltd. The pair shipped 88% of the 12 million analog and digital CO lines sold in 1986, according to Northern Business Information Inc. (NBI), a market research firm in New York City.

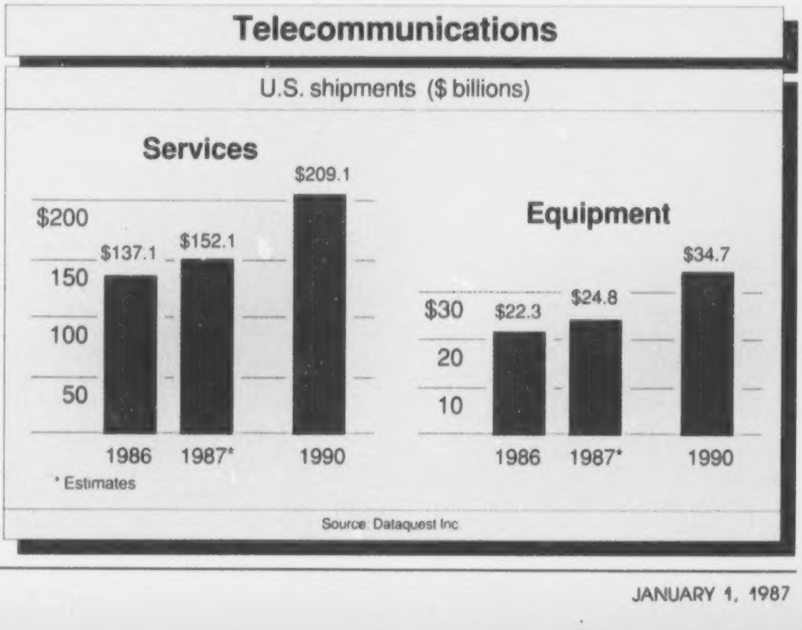
The largest customer base for CO switches — the seven regional Bell holding companies (RHCs) — accounted for the purchase of an estimated 85% of the approximately 11 million digital CO lines shipped last year, NBI estimates. These deep-pocketed customers are looking to add at least one other vendor to their lists of CO suppliers. This year many analysts expect to see a clear third vendor emerge. The two strongest contenders appear to be Siemens Communications Systems Inc., the Boca Raton, Florida-based subsidiary of Siemens AG, Munich, West Germany; and Ericsson Inc., the Richardson, Texas-based subsidiary of Sweden's L.M. Ericsson Telephone Co.

"If money can buy happiness, maybe it can also buy market share. And Siemens has tons of it," says Glenn Powers, senior analyst at NBI. He estimates that Siemens has spent hundreds of millions of dollars for both marketing and product development of CO and customer premises equipment (CPE). And, although globally Siemens "has a ton of lines on order," not many of them have been delivered, Powers says. Indeed, according to NBI's latest figures, Siemens only had a 1% share of the 21 million digital local lines (CO lines excluding trunks or toll switches) shipped worldwide in 1985.

Although Ericsson has gained less notoriety in the United States than its German rival, the firm has landed several agreements with many of the RHCs. Moreover, Ericsson has a leg up on Siemens in the worldwide market with a 10% share of the 1985 shipments of digital local lines, NBI says.

Switchboard struggles

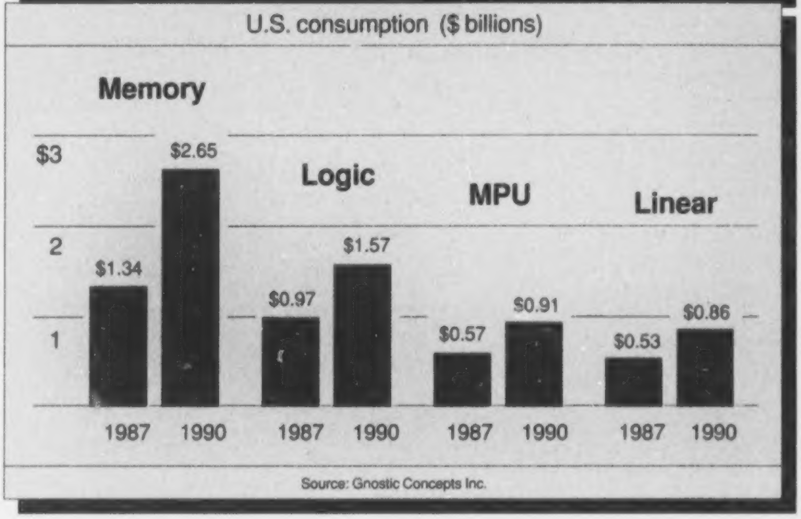
The five leaders in the U.S. market for private branch exchanges (PBXs) — AT&T, Northern Telecom, Mitel Corp., NEC Corp. and IBM's ROLM


Telecommunications

U.S. shipments ($ billions)

* Estimates

Source: Dataquest Inc.


Communication ICs

U.S. consumption ($ billions)

Source: Gnostic Concepts Inc.

Corp. — are expected to rack up a collective $500-million loss on their U.S. PBX sales this year. Nevertheless, 1987 is forecasted to be better for switchboard makers than the past several years, says Gregory Carlsted, an analyst at Dataquest Inc. The San Jose market research firm estimates that annual domestic PBX sales, which have hovered around $3.1 billion for the past few years, will rise 10% this year.

Fueling PBX demand, Carlsted says, will be an increase in volume sales as well as a rise in prices on middle-level and high-end products. The price hikes are driven by increased complexities such as the adding of office-automation functions and datacommunications features.

Sunny skies continue to elude the majority of vendors that sell key telephone systems (KTS). "It is extremely difficult to be profitable in this commodity market," Carlsted says. He reasons that the lack of growth in the KTS arena, with U.S. annual sales expected to remain flat the rest of the decade, will force company consolidations in this $2.1 billion telecommunications segment.

Bright lights

The segment that promises the most growth through 1990 is transmission equipment — a $5-billion U.S. market, pegged to grow to $5.5 billion by the end of this year and reach $7.3 billion by the end of 1990, according to NBI analyst Michael Miller. Representing $3.16 billion or more than half of the transmission equipment market, carrier equipment is expected to grow to $3.573 billion by the end of this year and hit $4.672 billion by the end of this decade. Included in carrier equipment, and the brightest performer in this segment, is fiber optics.

Although installation of fiber-optic cable and components is slowing in long-distance carrier applications, it is expanding at the opposite end of the network. Fiber optics at the distribution and subscriber loops (the parts of the network interconnecting central offices and reaching the end users) may, in fact, come to represent more than 90% of all network fiber installations, says Jon Zilber, director of West Coast operations for Kessler Marketing Intelligence, a market research firm.

In addition, the cost of fiber-optic components — the most price-intensive part of the market — is coming down. For example, the laser portion of a fiber-optic transmitter sells for an average price of $2,000, but one vendor recently announced a laser in the $500 to $600 price range. The industry expects to see $100 lasers in the not too distant future.

The total value of the domestic fiber-optics market is expected to grow from $875 million to $1.026 billion this year, reaching $1.838 billion by 1990, according to NBI's Miller. The major portion of this segment, fiber-optic electronics — which includes components such as lasers and light-emitting diodes — is expected to grow from $638 million to $766 million this year and reach $1.45 billion by 1990, Miller forecasts.

Fueling PBX demand will be an increase in volume sales as well as a rise in prices on middle-level and high-end products

Another hot communications item is T-1 networks — multiplexer-based digital transmissions systems that can handle voice or data or both at bit rates of up to 1.544 megabits per second. Unlike the key telephone system market, the T-1 multiplexer business can tolerate all of the players, believes Powers of NBI. "Demand seems to be pulling capacity," he says of T-1 sales. His firm estimates domestic sales for T-1 equipment will grow at least 30% a year from the current $250 million level.

The demand for state-of-the-art communications equipment is also pulling along semiconductor capacity. "The communications circuits area is one of the hottest IC segments in the industry at this time," says Ronald Ruebusch, director of marketing at Advanced Micro Devices Inc.'s Communications Products Division in Austin, Texas.

The growth in the communications segment of the semiconductor industry has not slowed despite an otherwise depressed IC marketplace, Ruebusch points out. The AMD executive expects growth to continue in 1987, a year when chips designed for integrated services digital-network (ISDN) applications will no doubt occupy center stage. Ruebusch cautions, however, that 1987 will be a design and prototype year for ISDN chips — not a money-making year for them.

During 1987 U.S. consumption of integrated circuits (ICs) in communications equipment is expected to grow 19% from $2.89 billion to $3.45 billion, according to Gnostic Concepts. By 1990 this figure is forecast to hit $6 billion, says Edward Pullen, a research director at the San Mateo, California-based market research firm.

The increasing sophistication of software used to run communications systems will stimulate demand for more processing power and greater memory capability. Gnostic Concepts forecasts the consumption of microprocessor units (MPUs) in communications equipment will climb from $570 million in 1987 to $910 million in 1990. The use of memory ICs in such equipment, meanwhile, will rise — from $1.34 billion to $2.65 billion, respectively.

On the down side, the advent of an

all-digital communications network will eventually diminish linear IC demand. Gnostic Concepts figures the market for such ICs used in communications equipment will only expand from $530 million in 1987 to $860 million in 1990. "In the short term, both digital and analog components will coexist," Pullen says. His long-term view sees linear IC producers targeting niche markets.

Linear functions will always be around because the world exists in analog form, AMD's Ruebusch argues. He does, however, foresee a dramatic shift in the placement of linear ICs. As telephone companies digitize the inner circles of their telecommunications networks through the use of such equipment as digital CO switches, linear functions such as analog to digital conversion will migrate to the outer reaches of networks — at the end user's premises. So, he expects to see a lot of linear ICs designed into customer premises equipment.

Regulatory roulette

The Modification of Final Judgement (MFJ) is the anti-trust settlement that divested AT&T of its local Bell operating companies (BOCs), and limited specific lines of business that AT&T and the BOCs could operate within. Since the conditions of the MFJ took effect on January 1, 1984, the seven regional Bell holding companies (RHCs) have been chipping away piecemeal at a number of restrictions set in the decree.

But 1987 might become the year of the wholesale dissolution of the MFJ, which many communications equipment manufacturers fear will quickly put an end to open competition. If the MFJ is vacated, then one of its key restrictions — forbidding the BOCs to manufacture equipment — would be lifted with it.

Meanwhile, Congress, the Courts and the Federal Communications Commission (FCC) are pounding out their own ideas vis-a-vis deregulation. Senate Majority Leader Robert Dole (R-Kan.) introduced a bill last June (S.2565) that would shift the jurisdiction of the anti-trust settlement from the U.S. District Court to the FCC. Even though this bill died before coming up for a vote in the 99th Congress, it is expected to reemerge in 1987.

What concerns equipment manufacturers is that FCC Chairman Mark Fowler favors the lifting of BOC restrictions. "Nobody wants to compete against its best customer," says John J. McDonnell, vice president of the Electronic Industries Association's Information and Telecommunications Technologies Group.

Added to this web of complexities is District Court Judge Harold Greene's awaited review of the MFJ, which is scheduled to take place this year. In the past, Judge Greene has been generous in granting the BOCs a large percentage of their requests for waivers. The results of his review could mean anything from the lifting of more restrictions to a decision to vacate the decree altogether.

"If the BOCs are allowed to do whatever they want to do," says a spokesman for the Computer & Communications Industry Association in Arlington, Va., "we will see considerable change within the industry, including many bankruptcies." ☐

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OUTLOOK '87

Distribution: A go-go industry faces so-so growth

Distributors no longer are banking on a big year to bail them out. They're facing up to some sobering facts

By Fred McGrail

After a long wait, 1987 was to be the year of recovery for the U.S. electronics distribution industry. Unless there is dramatic growth in the overall economy and a quantum leap in computer sales, which now seems unlikely, 1987 will not be yet another year of waiting. Instead, it will be a year of adjusting — to a new reality for distributors.

"I don't call this a recession. This is now normal business," says Jack Darcy, president and chief executive of Diplomat Electronics. "We [did not] have a recovery year in '86, and I see nothing on the horizon."

Another realist is Joseph Semmer, chief operating officer at Hall-Mark Electronics Corp. "There will be no significant change into 1987," Semmer says, although he does expect his company to grow 5% to 10% this year. "Every time we turn around there's another excuse."

The excuses for distribution's poor performance in 1986 are likely to be offered again in 1987. They include the continuing movement of manufacturing operations offshore, disappointing results from major computer manufacturers, high inventories and pricing pressures from both suppliers and customers.

Hamilton/Avnet Electronics, the largest U.S. distributor, is expecting modest growth in 1987. "We don't see any sudden change in demand," says Ed Kaniger, vice president for worldwide operations at Hamilton/Avnet. Weak sales and profits of computer manufacturers, distributors' major customers, seem to justify Kaniger's lack of enthusiasm.

W. Donald Bell, president of Ducommun Inc., the parent company of distributor Kierulff Electronics, is bearish for 1987. "We came out of the summer with all the roar and energy of a mouse, and it looks like we'll stay that way," he says. "It's going to be a tough year. I can't see any turn up."

Not everyone is as pessimistic about distribution's prospects for growth in 1987. The National Electronic Distributors Association (NEDA), which estimates that U.S. distributors sold $6.5 billion worth of components and systems in 1986, foresees the industry expanding 12% in 1987, assuming the overall economy grows 2.5% to 3.5%. "It's not great news," says Toby Mack, NEDA executive vice president. "But it's the kind of growth rates we're looking at for the near to long term." Andrew Neff, an analyst with San Francisco-based Montgomery Securities, also forecasts growth of 12% for this year, coming on the heels of approximately half that growth in 1986.

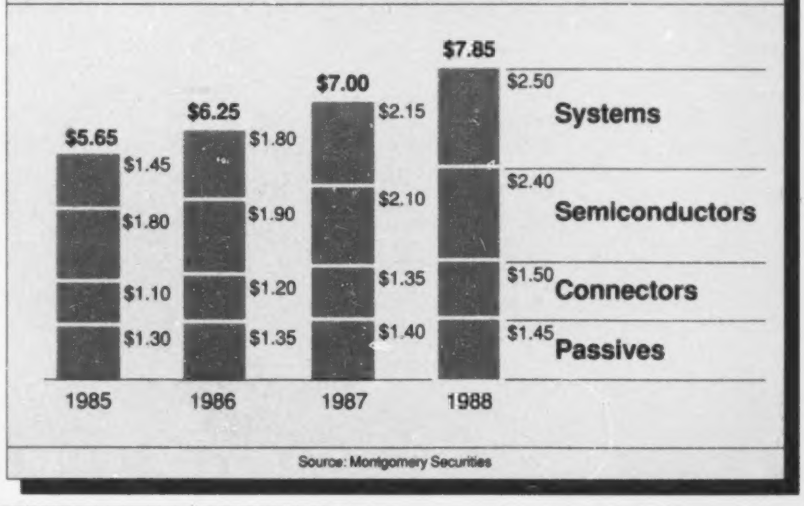
Ralph Ozorkiewicz, a vice president at Wyle Laboratories and president for the company's Electronics Marketing Group, is looking for his group's revenue to increase 15% to 20%. He sees strength in microcomputer systems and peripherals and in the military market. In addition, he says, the success of Digital Equipment Corp.'s MicroVax II has opened up the computer-aided design, engineering and manufacturing markets for Wyle.

One reason for Ozorkiewicz's optimism is his belief that his customers' inventories are down. "We've had 18 to 24 months of inventory depletion," the Wyle executive says, implying that computer makers and other major customers are going to have to call on distributors for vital components in 1987.

Others, however, read the inventory situation differently. "There's lots of inventory yet to be used," says Hamilton/Avnet's Kaniger. "We, as a distributor, are sitting on inventory," says Hall-Mark's Semmer. "We're 30% overvalued in semiconductors," meaning that chips are selling for 30%

Electronics distribution

U.S. sales ($ billions)



Source: Montgomery Securities

less than Hall-Mark's cost. NEDA's Mack observes: "Inventories are better than they were, but not good."

Ducommun's Bell thinks customer inventories are depleted, but says that it doesn't matter since lead times for components are short and parts are available. "Inventories are depleted, but they can get it [components] easily," he says. As for his company's inventories, Bell says they are high, with the exception of computer products.

Looking for new customers

The lack of activity by large computer manufacturers promises to keep a damper on semiconductor sales, which have traditionally accounted for about 40% of distributors' revenue. Semiconductor shipments to distributors will only increase 4% this year to $2.3 billion, predicts Jack Beedle, president of market research firm In-Stat Inc. "The mainframe manufacturers can soak up a lot of product," says Kaniger, who jokes that Hamilton/Avnet has done its part to stimulate mainframe sales with the purchase of an IBM 3090 model.

Distributors have been trying to offset the impact of the computer slump by finding new markets. Several companies, for example, rushed into military electronics — only to find it was less than the promised land. The rush to that market, along with tightened military procurement regulations, resulted in slashed profit margins and left some distributors complaining bitterly. Laments Hall-Mark's Semmer: "Our military sales are up, but our margins are down 2% to 3%."

Hamilton/Avnet's Kaniger wonders whether the stiff competition in the military market will really benefit the military. Despite the strong demand in the military market, he says, some established distributors may choose to leave it alone. "Profit is being reduced to such a point that it reduces interest in that market," Kaniger says. Still, the trend in military buying is toward multiple sourcing, doling out the business among many vendors.

Some distributors, in fact, blame military procedures, as much as cutthroat competition, for what they view as unacceptable profit margins. Wyle's Ozorkiewicz, for instance, believes that the military electronics business suffers from a "paralysis" as a result of government funding cuts. Kaniger says that the time and cost of complying with stringent military requirements makes the military business less attractive.

With pricing pressure intense in the military market and component sales sluggish in the computer market, the systems business has been critical to distributors' health. Distributors sales of computer systems and peripherals, which account for nearly 25% of total revenue, have held up despite the overall computer slump. "Microcomputer systems and peripherals have been strong," Ozorkiewicz confirms.

Some executives, however, see trouble ahead in systems — even in disk drives, one of the most lucrative peripherals for distributors. "I think we could have another semiconductor situation in the making," Ducommun's Bell says. "We may be filling up the pipeline, and then find there's no demand." Excess capacity is a potential threat, agrees analyst Neff. But he is confident that the demand for additional storage capacity by existing corporate owners of personal computers and workstations promises distributors continued growth in drive sales.

The emergence of just-in-time manufacturing strategies could make the distributor's role more important

Fundamental problems

Despite the relative buoyancy of their computer businesses, distributors are still under pressure from their suppliers to accept lower profits and from their customers to cut prices. Analyst Neff is blunt about the seriousness of the price pressure's effect on the distribution industry. "The reason distributors are losing money is that they can't get their margins," he says. "Distribution traditionally had 25% margins. Now, no one has more than 22%."

Part of the distributors' problem is that the playing field is too crowded, at least from the distributors' viewpoint. Distribution accounts for about 28% of the total U.S. component sales, competing not only among themselves but with other sources of supply. One reason customers can demand lower prices from distributors is that they are not the only pipeline for components and systems. Hamilton/Avnet's Kaniger sums up the situation this way: "There are too many, offering too much, to too few."

One sign of hope for the distribution industry is the emergence of just-in-time (JIT) manufacturing strategies. JIT, which essentially means that manufacturers order parts only as needed rather than stocking inventory, could make the distributor's role more important, Wyle's Ozorkiewicz suggests. "Quality enhancement and just-in-time delivery programs could change relationships [between distributors and customers] from the transactional buy-sell," he says. "JIT means different things to different customers. What the distributor brings to the party is service."

JIT could prove a boon to distributors, NEDA's Mack agrees. "I think distributors are laughing up their sleeves when they hear all the talk about JIT," he says. "JIT has been distribution's business forever. There's no need to do any strategic adjusting."

But not everyone sees JIT as an opportunity. "Large manufacturers with forecasted schedules can best benefit from just-in-time," says Diplomat's Darcy, "but those people are not large users of products by distribution. JIT won't create business. Our customers selling their end product will create business."

But, if customers continue to move manufacturing operations overseas, it won't matter to U.S. distributors how much those manufacturers sell because they will be buying components offshore. "It's scary," says Hall-Mark's Semmer, and worst of all there is virtually nothing that distribution firms can do to stop this exodus. Distributors are also far from convinced that any trade agreements will have a significant impact.

The news from Washington, D.C., is not entirely bad, however. The new tax law, in fact, should benefit distributors. In the past they paid an effective federal income tax rate of more than 40% due to their asset structure, with most assets current, and because they had little capital equipment to write off. The 40% figure will decline with the new tax law.

Tax reform, however, may turn out to be a mixed blessing for distributors, suggests analyst Neff. Both suppliers and customers are expected to view the new tax law as a windfall to distributors, and additional pressure may be put on distributors' profit margins. "The question is," Neff says, "who is going to keep it?" ☐

European electronics: An uncertain start to 1987

Mainframe computer and semiconductor vendors may be wary, but PC and telecom makers are looking forward to the new year

By Jack Gee

The new year opens in an uncertain mood for Europe's electronics industry. Few signs of a revival are visible on the semiconductor front. An abrupt fall in sales of mainframe computers lies in prospect. A battle royal also could be looming in telecommunications if other countries follow the example set by the United States and Britain in deregulating this sector of the industry.

"However, the manufacturers of professional personal computers can look forward to another excellent year in Europe," says Gordon Curran, associate director of Intelligent Electronics, the Paris-based market study company. "Demand for their products is still a long way from saturation."

For the semiconductor manufacturers, the old year has ended on a drearier note, with distributors' warehouses still laden with stubbornly high inventories. In spite of the agreement between the United States and Japan to work together against dumping, prices in Europe have remained depressed.

The Europeans have taken particular umbrage at an arrangement which, they complain, was hammered out behind their backs. Voicing its irritation, the Common Market Commission in Brussels, Belgium, is challenging the validity of the U.S.-Japan pact in the framework of the General Agreement on Tariffs and Trade (GATT).

Original equipment manufacturers say they are giving priority to shedding existing stocks of chips and completing work already in process. "And, after that, we're all asking ourselves what will happen," says James Beveridge, associate director of Dataquest's European Semiconductor Division. "There's a strong possibility that semiconductor sales in Europe may grow by only 7% in 1987."

Continental computers

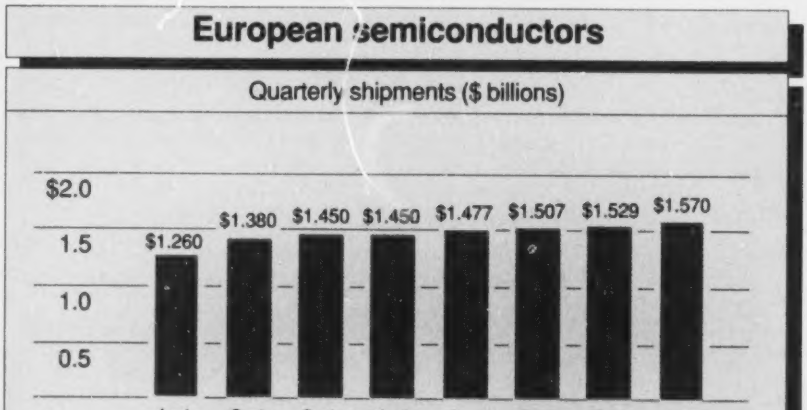
In contrast with their traditional practice, distributors failed to place orders during the last months of the year in the hope of doing seasonally good business at the start of the new year. Beveridge remarks: "The lack of confidence is visible throughout the semiconductor industry."

Faced by flagging demand for their own finished products, European computer systems makers are showing the same resistance to price increases for semiconductors as their counterparts on the other side of the Atlantic. Prices have stabilized in Europe following the establishment of prices for memory chips by the U.S. Department of Commerce in October.

The outlook is also gloomy for the mainframe computer market, particularly for IBM, the dominant contender. "It's difficult to see how IBM can avoid disappointing sales in Europe," says Emanuella Vitobello, a market analyst at International Data Corp.'s European headquarters in London.

IDC forecasts that IBM could see its installed base shrink between now and 1990 as networks of professional personal computers (PCs) burgeon in offices all over the continent. The market study group estimates that European sales of large multiuser processors — with price tags above $1 million — increased by 30% last year to $5,960 million. "But in 1987 sales are likely to rise by only 18%," Vitobello says. She stresses that Digital Equipment Corp.'s new VAX 8800 minicomputers are making inroads on traditional IBM sales in Europe. It is still premature to predict how the new IBM minis will perform in this arena.

However, there is a silver lining in the gray clouds that shroud the horizon of European electronics. Although growth rates are expected to be down from the previous year, the PC industry is likely to grow this year by a robust 25%, compared with 38% in 1986, according to Intelligent Electronics' Gordon Curran. He forecasts a particularly lively market for the nonprofessional range of Asian-made IBM PC clones priced between $500



Source: Dataquest Inc.

and $600. "These machines can be used for business," says Curran. "But their quality is not perceived as being up to the level required by corporate users."

At this lower end of the PC market, Intelligent Electronics expects strong sales in France, Germany and Britain. This last country is the home territory of the Armstrad PC, manufactured by London-based Armstrad Plc., which is storming its way into private homes in a style reminiscent of the Sinclair home computer, an earlier British design, at the end of the 1970s.

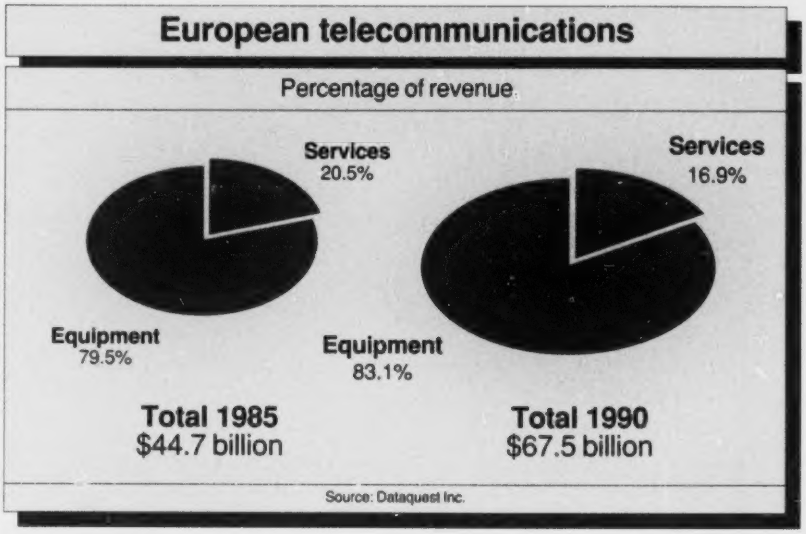
In the business sector, the big success story of 1987 is likely to be IBM's powerful AT model which last year boosted its share of the European PC market to 27% from 8% in 1985. "IBM may continue to lose market share to the clones among the less powerful PCs," says Curran. "But at the AT level they control 60% of the European sales."

With the introduction this year of new Microsoft software designed for Intel 80286-based models from IBM, Big Blue can look forward to highly successful business in Europe. In the computer-integrated manufacturing (CIM) sector, the IBM 6150, a high-powered PC for factory applications, will be challenged by a German rival, the Siemens PCD. "Germany is going to be the battleground because this is where the biggest CIM market in Europe lies," Curran says.

COMPAQ Computer Corp. is the first PC manufacturer to arrive in Europe with a 386 microprocessor model. But, in contrast to the United States, European buyers are likely to wait for IBM to present its own 32-bit PC before looking at COMPAQ or other makes.

Italy's Ing. C. Olivetti & Co. SpA, the No. 2 PC seller in Europe behind IBM, is expected to revamp its own range of PCs in 1987 in order to match those of the market leader. Already the price of the Italian M28, an AT equivalent, has been lowered to seek market share from IBM's XT 286. Reflecting a joint strategy devised with AT&T, which owns 25% of its equity, Olivetti is expected to incorporate a dual MS-DOS and Unix operating system in its new PC family.

Another successful performer in Europe is Apple Computer Inc.'s Macintosh which has increased its sales by 80% over the past year. The Mac owes its laurels to the strong takeoff by desktop publishing, first in Britain and more recently in France and Italy.



Source: Dataquest Inc.

Intelligent Electronics' Curran says: "Expect Mac to make good progress now that it's got its foot in the door of corporate Europe."

Telecom testimonial

While Hewlett-Packard Co. fares well with its laser printers in the desktop publishing market targeted by Apple, L.M. Ericsson and N.V. Philips' GL and are still only scratching the surface of the European office computer market. Nothing indicates that the Dutch and Swedish makers will do better this year.

The optimism of the PC makers is shared by the telecommunications manufacturers

"Europe is a particularly sophisticated PC market," Curran says. "In contrast with the U.S., where many people bought PCs as fashion-type purchases, the Europeans have been slower, but more businesslike in their approach. There's been much less impulse buying here."

Only 8.3% of Europe's white-collar workers use a desktop machine, compared with 20% in the United States. "And European penetration won't reach U.S. levels for another three years or so," Curran predicts.

The optimism of the PC makers is shared by the telecommunications manufacturers. Their achievements in Europe this year will depend on a series of moves that are awaited over the next few months. Sometime this fall, the West German government is likely to announce the first steps toward breaking up the Bundespost, the powerful state-controlled telecom body. There are also rumors of timid steps toward deregulation in France. A long-delayed effort might be launched to standardize the continent's seven incompatible cellular radio systems.

"This could be a year of opportunities," says Edward Richardson, senior industry analyst with Dataquest's European Telecommunications Service. "With new steps toward deregulation of telecom in Europe, perhaps this terribly fragmented market might at last pull itself together." He adds: "If these trends are confirmed, our telecommunications market could be set for a period of expansion."

It is also likely to be a year of matchmaking as Europe's telecom manufacturers seek partnerships to consolidate their design, production and marketing power. Last year was marked by the marriage between International Telephone & Telegraph Co. and France's Compagnie Générale d'Eléctricite. Future elopements could involve such suitors (or blushing brides) as Britain's General Electric Co., Plessey Co. Plc. and Italy's Italtel SpA. "There could be quite a few surprises," Richardson remarks.

While their colleagues in the semiconductor and computer mainframe businesses watch anxiously for signs of a revival, the telecommunications and personal computer manufacturers can allow themselves great expectations for 1987 in Europe. ☐

U.S. in Japan: Computers are up, but the chips are down

There is still only a small group of U.S. electronics companies that are making it in Japan's marketplace

By Paula Doe

The favorable U.S. dollar exchange rate gave a boost to some established U.S. companies in Japan in 1985, which continued to do well in the steady Japanese computer market. But semiconductor makers took a drubbing. And the list of U.S. electronics companies that are actually making money in Japan remains soberingly short.

At 200 yen to the dollar as the 1985 year-end rate, everyone's results look 20% better than they did the previous year with a rate of 250 yen to the dollar. But yen-based sales of the top 30 U.S. companies in Japan were also up an average 17%. Twenty-three U.S. companies had sales of $100 million or more in Japan in 1985, compared with only 13 firms in 1984. And 10 companies earned $10 million or more in comparison with only four the year before.

Still, Japanese electronics companies remain far bigger in the U.S. market than U.S. companies are in Japan. At least five big Japanese companies — Matsushita Electric Industrial Company Ltd., NEC Corp., Sony Corp., Sharp Corp. and Fujitsu Ltd. — had $1 billion or more in U.S. revenue in 1985. But only IBM Japan Ltd. and Fuji Xerox Company Ltd. cracked the billion-dollar sales mark in Japan. And Matsushita's $6.5 billion in U.S. sales dwarfed even IBM Japan's $4.6 billion in revenue. While the top five Japanese companies totaled U.S. sales of some $13 billion, all of the 30 top U.S. companies in Japan together managed only $12 billion sales.

Yen-based sales of the top 30 U.S. companies were up an average 17%

ELECTRONIC BUSINESS tracks results of corporations in Japan that are at least 25% owned by U.S.-based electronics companies and releases their sales figures. This includes all U.S. subsidiaries and joint ventures that are publicly listed on any of the Japanese stock exchanges, and those which break out their Japanese subsidiary results for release to the press, Japanese corporate directories or market research firms. Dataquest Inc. of San Jose, Calif., supplies U.S. semiconductor producers' sales in Japan. Our listing does not include results of companies that sell through agents in Japan.

Top 10 U.S. companies in Japan

Rank	Company	Sales ($ millions)	Percentage change 1984/1985	Net income ($ millions)
1	IBM Japan	$4,573	+19%	$365.0
2	Fuji Xerox	$1,609	+13%	$74.6
3	Nippon Univac	$676	+11%	$14.2
4	Texas Instruments Japan	$560	-17%	-$21.3
5	Commodore Japan	$525	+5%	N/A
6	Yokogawa-Hewlett-Packard	$524	+17%	$29.3
7	NCR Japan	$511	+14%	$45.7
8	Yamatake Honeywell	$442	+13%	$14.3
9	Sumitomo 3M	$431	+14%	$12.7
10	Burroughs	$409	+1%	$20.0

Sources: Company reports, Toyo Keizai Shuppansha's *Kaisha Shikiho: Mijojo Kaisha Han*, Dataquest Inc.

Some big U.S. computer makers are doing better in Japan now than they have done in years, thanks to favorable exchange rates, growing Japanese demand, and plain old hard work. IBM Japan has recently been the focus of considerable Japanese attention due to its comeback, as its strong 19% revenue growth and 43% taxable income growth begins to make up ground lost to rivals Fujitsu and NEC.

Nihon Digital Equipment Corp. is also making a strong showing. Revenue and earnings were both up 42% for the fiscal year ending June 1985. Revenue was up another 25% for the year ending June 1986, to $332 million or ¥54.8 billion (¥165=$1), while pretax earnings soared by a factor of five, to $80 million or ¥13.2 billion, for a healthy 24% margin. The hot product driving this growth is the MicroVAX II workstation. Nihon DEC shipped 718 of these units last fiscal year.

Japanese productivity

Many U.S. companies are successfully taking advantage of the legendary Japanese productivity. Average sales per employee of the top 30 U.S. companies in Japan was $185,700, some 70% more than the $110,800 average of the ELECTRONIC BUSINESS 200 for 1985. Naturally the figures of the U.S. companies in Japan tend to

Top U.S. companies in Japan ranked by sales

Rank	Company	Sales ($ millions)	Sales (¥ millions)	Percentage change 1984/1985	Net income ($ millions)	Net income as a percentage of sales	Exports as a percentage of sales
1	**IBM Japan**	$4,573	¥914,539	+19%	$365.0	8%	28%
2	**Fuji Xerox**	$1,609	¥321,701	+13%	$74.6	5%	18%
3	**Nippon Univac**	$676	¥135,182	+11%	$14.2	2%	0%
4	**Texas Instruments Japan**	$560[1]	¥112,043	-17%	-$21.3	-4%	43%
5	**Commodore Japan**	$525	¥105,000	+5%	N/A	N/A	N/A
6	**Yokogawa-Hewlett-Packard**	$524	¥104,899	+17%	$29.3	6%	10%
7	**NCR Japan**	$511	¥102,101	+14%	$45.7	9%	18%
8	**Yamatake Honeywell**	$442	¥88,383	+13%	$14.3	3%	22%
9	**Sumitomo 3M**	$431	¥86,138	+14%	$12.7	3%	N/A
10	**Burroughs**	$409	¥81,773	+1%	$20.0	5%	5%
11	**Mitsubishi Monsanto**	$360	¥71,904	+1%	$5.4	2%	N/A
12	**AMP (Japan)**	$252	¥50,420	+4%	N/A	N/A	N/A
13	**Nihon DEC**	$219	¥43,822	+42%	$3.7	2%	N/A
14	**Memorex Japan**	$137	¥27,338	+19%	$1.2	1%	N/A
15	**Nippon Data General**	$128	¥25,539	+78%	$2.0	2%	40%
16	**Yokogawa Medical Systems**	$116	¥23,208	+38%	$9.1	8%	30%
17	**Sony/Tektronix**	$114	¥22,770	N/A	N/A	N/A	N/A
18	**Nippon Avionics**	$114	¥22,739	+30%	$2.2	2%	N/A
19	**Nippon Univac Info. Systems***	$110	¥22,061	+26%	$0.5	<1%	N/A
20	**Nihon Business Computer**	$109	¥21,789	+93%	N/A	N/A	N/A
21	**Intel**	$108[2]	¥21,658	-21%	N/A	N/A	N/A
22	**Oki Univac**	$102	¥20,408	+63%	$1.4	1%	46%
23	**TEL-Thermco**	$102	¥20,318	+46%	$11.8	12%	0%
24	**Molex Japan**	$97	¥19,400	+7%	$13.5	14%	N/A
25	**Motorola**	$84[3]	¥16,898	-48%	N/A	N/A	N/A
26	**Mitsubishi Precision**	$74	¥14,735	+4%	$0.8	1%	N/A
27	**Applied Materials Japan**	$65	¥12,960	+5%	$1.9	3%	0%
28	**TEL-Varian**	$51	¥10,100	+23%	N/A	N/A	N/A
29	**Elco International**	$50	¥9,950	+8%	$4.5	9%	N/A
30	**Nemic-Lambda**	$50	¥9,932	-5%	$2.4	5%	N/A

All yen are converted at the 1985 year-end rate of ¥200 = $1 for purposes of comparison. Dollar results reported by companies whose fiscal years ended September, to November 1985 will be 1% to 9% lower than our figures due to the changing exchange rates. The actual end-of-period rates are as follows:

March 1985: ¥253 = $1
June 1985: ¥249 = $1
September 1985: ¥217 = $1
October 1985: ¥212 = $1
November 1985: ¥202 = $1
December 1985: ¥200 = $1
March 1986: ¥180 = $1
June 1986: ¥165 = $1

* Nippon Univac Information Systems

[1] Semiconductor sales in Japan were $319 million

[2] Semiconductor sales in Japan

[3] Semiconductor sales in Japan were $32 million

Productivity

Sales per employee	Net income per employee	Fiscal year ended	Contribution to parent company	Ownership
$244,700	$19,500	12/85	9%	IBM, 100%
$146,300	$6,800	10/85	9%	Rank Xerox, 50%; Fuji Shashin Film, 50%
$164,000	$3,500	3/86	4%	Sperry, 34.2%; Mitsui & Co., 34.2%
$119,200	$4,600	12/85	11%	Texas Instruments, 100%
N/A	N/A	6/86	N/A	Commodore Computer, 100%
$187,300	$10,500	10/85	6%	Hewlett-Packard, 75%; Yokogawa Hokushin, 25%
$117,300	$10,500	11/85	8%	NCR, 70%
$127,600	$4,200	9/85	3%	Honeywell, 50%
$211,100	$6,200	10/85	3%	3M, 50%; NEC, 25%; Sumitomo Electric Industrial, 25%
$154,300	$7,600	12/85	8%	Burroughs, 100%
$280,200	$4,200	12/85	3%	Mitsubishi Chemical, 51.2%; Monsanto, 48.8%
$241,000	N/A	12/85	15%	AMP, 100%
$133,600	$2,300	6/85	3%	DEC, 100%
$390,600	$3,300	12/85	2%[4]	Memorex, 60%; Kanematsu Gosho, 40%
$149,200	$2,400	9/85	9%	Data General, 85%; Kozo Design Laboratory, 12.6%
$178,500	$14,000	3/85	<1%	General Electric, 51%; Yogogawa Hokushin, 49%
N/A	N/A	N/A	4%	Sony, 50%; Tektronix, 50%
N/A	N/A	N/A	<1%[5]	NEC, 51%; Hughes, 49%
$172,400	$750	3/85	1%[6]	Nippon Univac, 100%
$93,100	N/A	3/85	<1%[7]	IBM Japan, 35%
N/A	N/A	12/85	7%	N/A
$160,500	$2,200	3/85	1%	Sperry, 45.1%; Oki Electric, 31.2%; Mitsui & Co., 15%; Mitsubishi Electric, 8%
$211,700	$24,600	9/85	N/A	TEL, 50%; Thermco, 50%
$104,300	$14,500	6/85	38%	Molex, 100%
N/A	N/A	12/85	2%	N/A
$86,400	$950	3/85	1%	Mitsubishi Electric, 42%; Singer, 40%; Mitsubishi Heavy Industries, 10%
$432,000	$12,500	10/85	37%	Applied Materials, 100%
N/A	N/A	9/85	2%	TEL, 50%; Varian, 50%
$199,000	$18,000	6/85	N/A	Wickes, 100%
$153,300	$7,500	9/85	24%	Veeco Instruments, 72%; Yoshihiro Madarame, 28%

[4] Percentage of revenue of Memorex parent, Burroughs
[5] Percentage of revenue of Hughes parent, General Motors
[6] Percentage of revenue of Nippon Univac parent, Sperry
[7] Percentage of revenue of IBM Japan parent, IBM

Contribution to parent is (percent ownership x Japanese subsidiary's sales) / parent sales
Ownership figures include those holders of 5% or more equity
N/A = not available

Sources: Company reports, Toyo Keizai Shuppansha's *Kaisha Shikiho: Mijojo Kaisha Han*, Dataquest Inc.

be high because many of these subsidiaries merely sell products that are designed and produced in the United States. And subsidiaries are spared the weight of the parent's corporate staff and engineers. Still, even those subsidiaries of U.S. companies that produce most of their products in Japan, like IBM Japan, Texas Instruments Japan Ltd. and Fuji Xerox, have sales per employee roughly twice that of their U.S. parents. Many of these companies are effectively using Japanese managers and the dedicated Japanese workforce to build themselves an extremely efficient production base.

But very few U.S. companies are getting any major portion of their business from the Japanese market. Only five companies of the top 30 companies made as much as 10% of their sales in Japan. The average Japanese subsidiary's contribution to parent revenue was a mere 8%. Those doing the biggest proportion of their business in Japan tend to be those that supply components or equipment to the huge Japanese electronics sector rather than those that sell equipment or systems to end users. Sales of Molex Japan Company Ltd. came to 38% of Molex International Inc.'s total 1985 revenue. Applied Materials Japan Inc. contributed 37% to Applied Materials Inc.'s sales. And sales of Veeco Instrument Inc.'s 72%-owned joint venture Nemic-Lambda came to 24% of Veeco's total.

And, according to income-tax data released by the Japanese government, even fewer U.S. companies manage to make much money in the Japanese market. Although these pretax earnings figures include various loss carry-overs and tax credits, and doubtless a host of other creative accounting methods to reduce tax liabilities as well, figures are available for all businesses incorporated in Japan. But even with the boost from the favorable exchange rate, the list of U.S.-owned companies making real money in Japan is depressingly short. We found 46 companies that reported $1 million or more in taxable income to the Japanese government — presumably that translates roughly to a mere $500,000 in after-tax earnings. And only 18 companies earned $10 million or more before taxes.

More than half of the million-dollar club saw earnings drop, in 1985, by an average of 28%. But a few companies did see big gains, paced by ITT Cannon with 553%, TEL-Lam Ltd. with 378%, Ampex Japan Ltd. with 193%, and Nihon DEC with 145%. ☐

Top U.S. companies in Japan ranked by taxable income

Rank	Company	Taxable income ($ millions)	Taxable income (¥ millions)	Percentage change 1984/1985
1	**IBM Japan**	$780	¥155,983	+43.2%
2	**Fuji Xerox**	$160	¥32,005	-9.8%
3	**NCR Japan**	$91	¥18,118	+3.2%
4	**Yokogawa-Hewlett-Packard**	$47	¥9,335	-27.0%
5	**AMP (Japan)**	$37	¥7,419	-14.4%
6	**Yamatake Honeywell**	$37	¥7,399	+11.6%
7	**IBM Japan Sales**	$36	¥7,183	+0.4%
8	**Burroughs**	$33	¥6,510	-32.6%
9	**Nippon Univac**	$30	¥5,910	-1.2%
10	**Molex Japan**	$29	¥5,719	-6.1%
11	**Sony/Tektronix**	$28	¥5,524	+0.4%
12	**Yokogawa Medical Systems**	$26	¥5,288	+94.9%
13	**Sumitomo 3M**	$23	¥4,625	-20.1%
14	**TEL-Thermco**	$23	¥4,615	+32.8%
15	**Nihon DEC**	$15	¥3,039	+144.9%
16	**Mitsubishi Monsanto**	$14	¥2,813	-7.2%
17	**GE Technical Service****	$13	¥2,588	+20.0%
18	**Elco International**	$12	¥2,300	+3.2%
19	**Nippon Avionics**	$6.4	¥1,282	+24.6%
20	**TEL-Varian**	$6.4	¥1,272	+46.9%
21	**Nippon Tylan**	$4.4	¥886	+47.4%
22	**Shipley Far East**	$4.2	¥847	-28.2%
23	**Nemic-Lambda**	$4.0	¥809	-36.0%
24	**Nippon Data General**	$4.0	¥791	-28.2%
25	**Memorex Japan**	$3.9	¥772	-26.1%
26	**Analog Devices**	$3.9	¥770	-36.4%
27	**Applied Materials Japan**	$3.8	¥757	-40.3%
28	**Ampex Japan**	$3.2	¥641	+192.7%
29	**Nihon Business Computer**	$3.2	¥631	*
30	**TEL-Lam**	$2.5	¥497	+377.9%
31	**Mentor Graphics Japan**	$2.2	¥442	*
32	**Burr-Brown Japan**	$2.1	¥418	-4.3%
33	**TEL-Genrad**	$2.0	¥399	+12.7%
34	**Nippon Calcomp**	$2.0	¥393	-2.7%
35	**Teijin Memorex**	$1.9	¥389	-63.7%
36	**Mitsubishi Precision**	$1.9	¥381	+35.1%
37	**ITT Cannon**	$1.5	¥307	+553.2%
38	**Perkin-Elmer Japan**	$1.5***	¥298	*
39	**Apple Computer Japan**	$1.4	¥276	-32.7%
40	**Thomas & Betts Japan**	$1.3	¥258	-11.9%
41	**Burndy Japan**	$1.3	¥255	-78.9%
42	**General Instrument Japan**	$1.2	¥246	-72.2%
43	**Harris**	$1.2	¥242	*
44	**General Electric Japan**	$1.2	¥236	-48.9%
45	**Teledyne Japan**	$1.1	¥224	-8.2%
46	**Hirose Cherry Precision**	$1.0	¥199	-23.8%

Taxable income reported to the Japanese government for fiscal year 1985. Some figures may include tax losses carried forward from previous years.

All yen converted at ¥200 = $1 for purposes of comparison.

* 1984 taxable income less then ¥40 million ($163,000 at March 1985 rate of ¥245 = $1)

** General Electric Technical Service

*** Figures for partial year only because of change in company fiscal year

Sources: Company tax forms released by the Japanese government, compiled by Teikoku Data Bank, and published by Toyo Keizai Shuppansha in Hojin Shotoku 50,000 Sha Rankingu and Shukan Toyo Keizai: Kaisha Shikiho Mijojo Kaisha Han

Image processing: Picture-perfect opportunities

Image processing may not be the next hula hoop, but the market has the same applications potential as the human eye

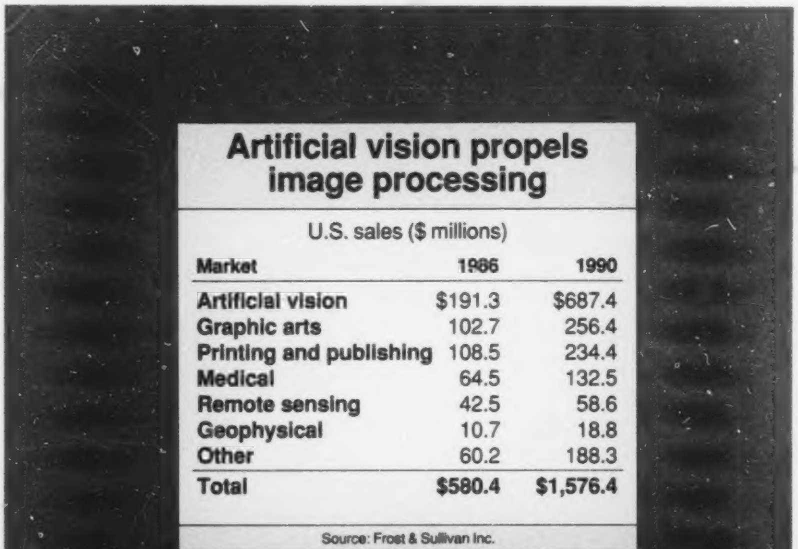
By David Card

Those murky shots of the H.M.S. *Titanic*'s anchor chains brought image processing into the public eye if not its vocabulary. Actually, the TV scenes would have been a lot murkier without filtering, just one of the applications of image-processing technology. Medical scanning and satellite snooping — two other applications — have been around for years. Machine vision, despite the bashing the robotics industry has taken, is a hungry consumer of image technology. Now, as single-chip processors become available and electronic publishing continues to be hot, the image-processing market should blossom.

THE MARKET

"Potential" is a word you hear a lot around the image-processing market. "It's not a horribly big market right now," says Albert Winegar, president of VICOM Systems Inc., "but potentially there are great opportunities." Last year, San Jose, California-based VICOM sold $15 million worth of its specialized image-processing computers and subsystems, Winegar says, mostly for medical and geological applications.

"It's the type of thing where you say: Where's the market? It's all fluff." adds Stephen Silver, president of Imaging Technology Inc. (ITI) in Woburn, Mass. But Silver says this mostly in reference to venture capitalists' disenchantment with the machine-vision industry — he thinks the potential applications for image processing could parallel those of human sight. "The industry in many ways is not big yet," Silver admits. "But the potential is enormous."



Artificial vision propels image processing

U.S. sales ($ millions)

Market	1986	1990
Artificial vision	$191.3	$687.4
Graphic arts	102.7	256.4
Printing and publishing	108.5	234.4
Medical	64.5	132.5
Remote sensing	42.5	58.6
Geophysical	10.7	18.8
Other	60.2	188.3
Total	**$580.4**	**$1,576.4**

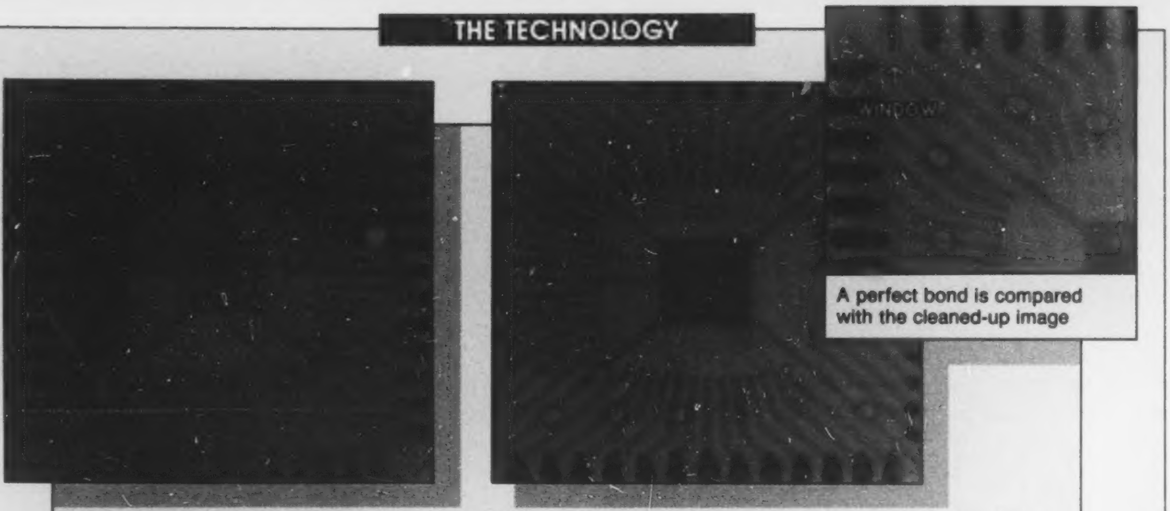
Source: Frost & Sullivan Inc.

ITI competes somewhat with VICOM, selling add-on boards for personal computers (PCs). The company's subsystems were in part responsible for cleaning up the dramatic footage of the sunken *Titanic*. ITI had $11 million in 1986 sales, a relatively slow year, Silver says, because of those machine-vision vendors [ELECTRONIC BUSINESS Oct. 15, 1986 p52] that accounted for 16% of ITI's sales, a percentage that Silver expects to shrink.

The sales figures for the market for image-processing systems and subsystems are not too bad to begin with. The 1986 U.S. estimates range from Frost & Sullivan Inc.'s $580 million to The Yencharis Consulting Group's $966 million. Yencharis, out of North Masapequa, N.Y., forecasts 14% growth through 1988; New York City's Frost & Sullivan, 30.6% from 1985 to 1990. Richard Schwarz, a vice president at E.F. Hutton & Company Inc., points out that image processing, while taking hits due to the auto industry (General Motors Corp. cutbacks) and the oil slump, still held up better than most electronics segments.

Edward Carl, marketing vice president for Gould Inc.'s Imaging and Graphics Division in Fremont, Calif., breaks the image-processing market into seven segments. Gould sold $24 million worth of subsystems to the markets of graphic art, remote sensing (geological satellites), publishing, defense, research and development, medical, and industrial automation, he says, with most sales in graphics,

THE TECHNOLOGY



A perfect bond is compared with the cleaned-up image

IMAGE PROCESSING is at the heart of an IRT Corp. system for inspecting solder bonds of surface-mounted components. A "noisy" X ray (left) is cleaned up (right) by processing boards from ITI

Seeing more clearly

The technology of image processing arose early in the space race, when the unmanned Ranger 7 observed the moon. NASA scientists asked, "Why take up room on the tiny spacecraft with elaborate cameras?" They figured they could get by with a low-quality picture that could be digitally doctored when they received it back on earth.

The actual processing is only one component of a vision- or imaging-system. An image must be captured, often from a TV camera, and its analog light signals converted into digital pulses that a computer can handle. Image-processing algorithms — mathematical logic sequences embedded in hardware or written as software — manipulate the digital images before they are converted back into analog video pictures or printed out.

Image processing is a distinctly different technology from computer graphics, where the images are not from life but are man- or machine-made. Graphics are easier to manipulate than images because graphics are defined to a computer's "mind" as geometric figures — a set of points and a few other bits of information regarding shading or coloring. In contrast, a captured TV picture suitable for image processing contains some 200,000 individual picture elements, or pixels, each its own shade of gray or color.

Image processing uses some off-the-shelf hardware — converting light to electric charges via charge-coupled devices (CCDs) and crunching numbers with array processors — so it is the processing subsystems and their algorithms, often embedded in custom chips, that make up the value-added. These processes include highlighting, changing contrasts, moving, stretching, comparing and adding color to images.

For instance, to measure a drilled hole, the image processor takes the hole's image and converts all the pixels that are as dark as the hole to black and all those lighter to white. Then the vision system simply counts the black pixels. The real image-processing task is to make the artificial-intelligence job of pixel-counting easier. Another example would be overlaying an image of a newly finished circuit board on top of one known to be correct. If any chips were misplaced or misaligned, the algorithm recognizes and displays the mistake. ☐

publishing and defense. Gould technology helped defog the National Aeronautics and Space Administration's (NASA) probe into the *Challenger* disaster by filtering out smoke from video tapes. Carl says that profitability, rather than acquiring the technology, was the primary attraction behind Gould's acquisition of DeAnza Inc. a few years ago.

COST OF ENTRY

"There are barriers to entry," says E.F. Hutton's Schwarz. "Generally they're very low. There are barriers to survival — they ain't so low. And there are barriers to prosperity — they're high." The technology is not the limiting factor, Schwarz says, it is distribution. If the start-ups that populate the image-processing market cannot get the proverbial salesman's foot in the door, they are in trouble.

James McNaul, vice president of document scanner company Datacopy Corp., agrees entirely. Datacopy's case is different than that of the subsystems companies — scanners are sold as a peripheral to PCs, whereas subsystems are sold first to a systems integrator and then to the end user. Still, McNaul says funding the technology was the easy part. The Mountain View, Calif., company raised $4 million in venture capital, then about $9 million more in its initial public offering. The company has a joint development effort going on with Ricoh Company Ltd. But now McNaul's full-time duty is lining up distribution channels — original equipment manufacturers (OEMs) like Apollo Computer Inc., Interleaf Inc. and AM International's Varityper Division, and a host of dealers and value-added resellers.

McNaul says that although Datacopy is really only a high-end scanner maker, the company is forced to absorb the lower margins of medium-range scanners and even resell a low-end model to make the entire line attractive to dealers. "Dealers want

Photos courtesy of Imaging Technology Inc.

one supplier," he says. "But if we can train the dealer to sell the high-end products, the low-end is an easier sell — they'll go like peanuts." With volume comes profits, no matter what the margins.

ITI is a good example of a company getting into a market cheaply. The three-year-old company raised only $2.25 million in venture capital, bootstrapping its R&D by hitting profitability in its third month. ITI, however, did spend 18% of its sales on its own R&D last year, including over $1 million developing custom gate arrays. ITI's Silver says that 2.5 years ago he bought two computer-aided engineering workstations from Mentor Graphics Corp. and some more from Cadnetix Corp. to design chips and boards. He has the chips made by LSI Logic Corp. and is starting to second-source them from Toshiba Corp.

Although ITI does not build its chips, it does assemble the circuit boards they inhabit. To squeeze the boards into a PC's chassis, Silver went to surface-mounted components. This called for some $150,000 worth of special assembly equipment.

ITI's low sticker price — some boards cost under $2,000 — has resulted in a long list of customers and OEMs for ITI. Quad Systems Corp. of Huntington Valley, Pa., makes the kind of pick-and-place assembly equipment that ITI bought for its surface-mount facility. Quad chief financial officer Jeffrey Randall says that buying an image-processing subsystem involved "the same kind of decision as choosing a microprocessor for electromechanical gear." Quad buys from International Robomation Intelligence as well as ITI.

Synthetic Vision Systems, a supplier of high-end image processing computers out of Ann Arbor, Mich., broke off an OEM arrangement with VICOM and now buys some image-processing boards from ITI, according to director of sales and marketing Dave Trail. Early on, SVS saved some of the development costs of its visual inspection system by using core technology developed by a University of Michigan program. To develop a low-end entry into the image-processing market, even the deep-pocketed Minnesota Mining and Manufacturing Co. (3M) went to ITI to help out its Comtal/3M subsidiary in Pasadena, Calif. Comtal/3M makes general purpose image-processing systems with sales that are especially strong in the printing industry. Marketing operations director Karen Sauve says that Comtal/3M can better spend its development money on its high-end systems.

VICOM's ALBERT WINEGAR: "Potentially there are great opportunities" in image processing

Liane Enkelis

THE COMPETITION

Sellers of image-processing systems and subsystems — and there are hundreds, according to analysts — generally acknowledge that their stiffest competition comes from the internal development operations of potential customers, rather than from each other. Cognex Corp. of Needham, Mass., chose to bypass the middleman and build its own image-processing technology for its systems that visually inspect circuit boards. Allan Wallack, chief operating officer, says that if image-processing hardware were a commodity, with no potential for added value, he would buy it. The current offerings, he says, "are very, very general-purpose modules," with much more flexibility and power than he needs to do a given job.

Big companies will go to strategic partnerships to acquire the technology

In a similar vein, Datacopy's McNaul says: "Our feeling is that image processing is our core business and we don't want to lose control of it." The image resolutions that Datacopy works with are beyond the reach of ITI's current product offerings. ITI's Silver admits he cannot compete in every segment of the market, and he takes heart in the lack of large competitors — so far. "An interesting thing about this industry is that there are no major forces in the business," he says. "The big, quote, imaging companies, unquote, are not in the industry." ITI claims Eastman Kodak Co. and E.I. du Pont de Nemours and Co. as customers.

"At this point the industry is not big enough for them to be horribly interested," VICOM's Winegar says of the big computer companies. He also claims Kodak as a customer, as well as IBM and Digital Equipment Corp. "It's tough for a big company like Gould to be competitive in the low-end market and make its margins," admits Gould's Carl. E.F. Hutton's Schwarz agrees. "You're not going to roll out a general purpose image processor and do a billion dollars of business," he says.

Schwarz predicts that big companies will go to strategic partnerships to acquire the technology. He says that all of the companies out of the handful of image-processing firms that he considers the original pioneers — save VICOM — have been acquired. VICOM's Winegar points out that he has a large OEM agreement with General Electric Co. and that GE is an investor.

Still, analyst Leonard Yencharis thinks that imaging will be a major battleground for the computer giants, and E.F. Hutton's reports always mention the camera giants with hushed awe. Image processing, at least in its use of direct electronic translation of a real-life image to digital form — without conventional film — is a potential threat to camera and film companies. Kodak (which already owns scanner supplier Eikonix) and others may have to develop the technology defensively.

Gould's Carl sees two new potential competitors — Ramtek Corp. and Pixar. Ramtek makes imaging-display terminals and graphics workstations, and Pixar, Apple Computer founder Steven Jobs' latest project, is a special effects company — originally spun out of Lucasfilm Ltd., the brainchild of *Star Wars* creator George Lucas. Carl says the differences between graphics and imaging are rapidly dissolving.

It could be tough to keep the big guys out much longer. As Datacopy president Rolando Esteverena says of Xerox Corp.: "They're not so much a competitor as foregone business."

THE OBSTACLES

There does not appear to be all that much in the way of image processing as a technology. Still, a conventional drawback to young industries is always a lack of standards.

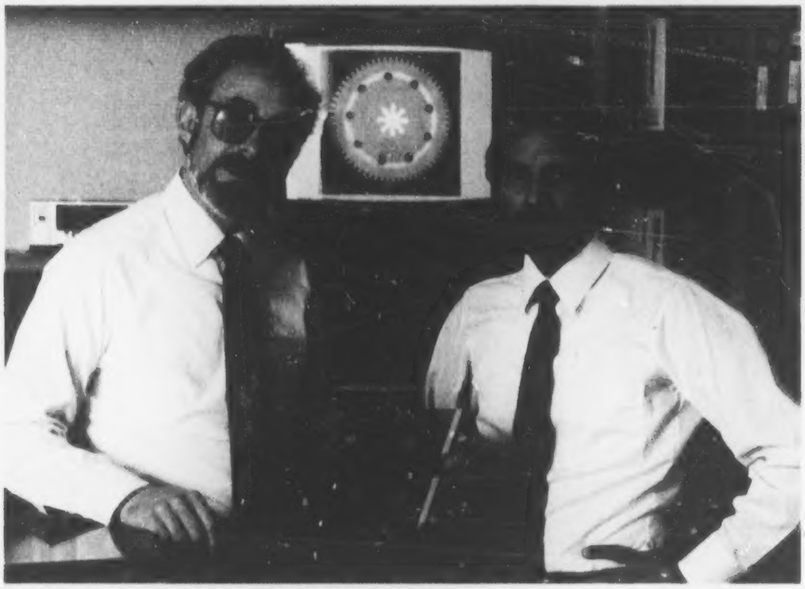
ITI's Silver says that a library exists consisting of 150 to 200 more or less generic image-processing algorithms. On the contrary, Gould's Carl contends that a lack of generic algorithms is one of the things holding back the industry, particularly the machine-vision segment.

Datacopy may have taken a step toward a conventional programming language, at least for scanners. The company is posing its PreScript as a counterpoint to the electronic-publishing industry's PostScript, from Adobe Systems Inc., the page-description language to drive laser printers. Whereas Postscript is used at the end of the publishing process, PreScript is used in the beginning — it breaks down a page for scanning, according to Datacopy president Esteverena.

Yet PostScript, as much a standard as possible, is opposed by a handful of the biggest publishing competitors. If Postscript's acceptance is analogous to PreScript's, then the language will need some heavy hitters behind it.

Besides standards, there are some key peripheral technologies crucial for the success of image processing. One is memory. A page of text scanned by pixels, when stored in a computer, takes a megabyte of storage. For comparison, that same page, stored the way a word processor would store it, takes one-twentieth of that space. Color images are three times as memory consuming. For mass storage, optical disks offer potential. "We're not ready to move to optical disks yet," cautions Sauve of Comtal/3M. "The technology just is not there." Locally, higher capacity memory chips — at low prices — are a must for image manipulation.

DATACOPY's ROLANDO ESTEVERENA: It could be tough to keep the big guys out much longer


ITI's Stephen Silver (left) and Rashid Beg: "An interesting thing about this industry is that there are no major forces in the business," says Silver

Other chips that support image processing are not so problematic. ITI's Silver says he has seen analog-to-digital converters drop in price from $700 to $50, and he crunches a lot of numbers with digital signal processors from Zoran Corp. He does admit, however, that most of his so-called library of algorithms were written for black and white images, and that some refinement for color is needed.

Matsushita Electric Industrial Co. of Osaka, Japan, has a new image-processing chip on the market. Masaharu Noyori, an administration manager for the company's semiconductor research center, says the chip is aimed at the factory automation field, specifically for production-line surveillance.

Overall, the obstacles to image processing are minimal, says Schwarz of E.F. Hutton. All the key technologies — image capture, analog conversion, processing, storage and display — are proceeding on their own. "There is a mini-industry pushing each one," Schwarz says. ☐

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	7	27	47	13	6	0	8.1	8.1
Pot-Core	0	33	34	17	8	0	8.2	6.9
Laminate (power)	5	36	36	18	5	0	7.7	9.0
CONNECTORS								
Military panel	0	22	56	11	11	0	9.6	3.6
Flat/Cable	23	50	18	9	0	0	3.9	3.4
Multipin circular	7	13	60	13	7	0	8.9	4.0
PC	12	41	29	18	0	0	6.0	5.1
RF/Coaxial	23	53	6	18	0	0	4.4	1.8
Socket	17	48	22	13	0	0	4.7	4.7
Terminal blocks	15	48	33	4	0	0	4.2	4.1
Edge card	15	50	20	10	5	0	5.5	6.1
Subminiature	10	40	35	10	5	0	6.5	5.1
Rack & panel	8	46	31	15	0	0	5.8	7.4
Power	14	50	22	7	7	0	5.7	5.0
PRINTED CIRCUIT BOARDS								
Single-sided	0	50	45	5	0	0	5.4	4.9
Double-sided	0	62	38	0	0	0	4.3	5.1
Multilayer	0	30	57	13	0	0	7.2	7.1
Prototype	0	89	11	0	0	0	2.7	2.2
RESISTORS								
Carbon film	50	24	21	6	0	0	3.1	2.2
Carbon composition	37	21	21	21	0	0	5.4	4.0
Metal film	38	27	29	6	0	0	3.8	3.8
Metal oxide	36	18	37	0	9	0	5.6	5.3
Wirewound	25	17	46	8	4	0	6.4	7.7
Potentiometers	23	20	40	13	4	0	6.6	7.7
Networks	31	27	31	4	7	0	5.6	5.2
FUSES	48	23	26	3	0	0	3.0	2.7
SWITCHES								
Pushbutton	20	33	40	7	0	0	4.9	5.4
Rotary	5	45	45	5	0	0	5.3	6.1
Rocker	17	39	35	9	0	0	5.0	4.6
Thumbwheel	13	27	33	27	0	0	7.5	8.2
Snap action	33	25	33	8	0	0	4.5	6.9
Momentary	7	43	43	7	0	0	5.4	5.7
Dual in-line	17	41	25	17	0	0	5.5	5.7
WIRE AND CABLE								
Coaxial	44	22	28	6	0	0	3.6	1.9
Flat ribbon	30	44	22	0	4	0	3.6	2.5
Multiconductor	23	53	18	0	6	0	4.0	1.6
Hookup	48	42	10	0	0	0	1.7	1.5
Wire wrap	40	33	27	0	0	0	2.8	2.1
Power cords	25	36	32	7	0	0	4.4	3.5
Other	0	80	20	0	0	0	3.2	5.3
POWER SUPPLIES								
Switching	0	25	50	20	5	0	9.0	5.2
Linear	11	22	44	17	6	0	8.1	4.8
CIRCUIT BREAKERS	17	31	35	13	4	0	6.6	5.7
HEAT SINKS	24	40	28	8	0	0	4.3	3.5

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	23	27	31	15	4	0	6.5	5.5
PC board	14	27	27	27	5	0	8.3	7.1
Dry reed	18	9	37	27	9	0	10.0	8.7
Mercury	11	22	22	34	0	11	11.0	6.0
Solid state	17	33	17	28	0	5	8.2	7.6
DISCRETE SEMICONDUCTORS								
Diode	39	21	32	5	3	0	4.5	3.4
Zener	30	28	30	12	0	0	4.9	5.0
Thyristor	19	38	25	12	6	0	6.4	4.5
Small signal transistor	35	15	25	20	0	5	7.1	5.1
FET, MOS	5	45	30	10	5	5	7.8	7.1
Power, bipolar	31	25	38	6	0	0	4.5	6.7
INTEGRATED CIRCUITS, DIGITAL								
CMOS	11	33	34	15	7	0	7.6	4.5
TTL	36	24	32	4	4	0	4.7	4.5
LS	29	26	37	4	4	0	5.0	4.3
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	14	14	58	7	7	0	7.9	4.0
OP amplifier	11	31	31	23	0	4	8.0	6.5
Voltage regulator	19	35	23	19	0	4	6.8	4.5
MEMORY CIRCUITS								
RAM 16k	17	25	33	17	0	8	8.4	4.6
RAM 64k	19	38	25	12	0	6	6.7	4.5
RAM 256k	23	12	47	12	0	6	7.7	5.8
ROM/PROM	25	8	50	8	0	9	8.0	7.2
EPROM	13	33	33	17	0	4	7.3	5.5
EEPROM	19	19	37	19	0	6	8.3	7.8
DISPLAYS								
Panel meters	13	40	40	0	7	0	5.7	5.6
Fluorescent	20	10	30	30	10	0	10.0	8.5
Incandescent	25	0	50	12	13	0	9.3	8.4
LED	14	36	39	7	4	0	5.9	4.9
Liquid crystal	7	7	66	20	0	0	8.7	7.8
MICROPROCESSOR ICs								
8-bit	25	19	38	12	0	6	7.3	7.1
16-bit	5	32	42	16	0	5	8.2	4.3
FUNCTION PACKAGES								
Amplifier	28	18	27	18	0	9	8.3	6.0
Converter, analog to digital	0	37	18	36	0	9	10.8	10.2
Converter, digital to analog	0	20	50	20	0	10	10.7	11.3
LINE FILTERS	9	36	37	9	9	0	7.5	5.3
CAPACITORS								
Ceramic	23	33	34	10	0	0	4.9	5.0
Ceramic monolithic	12	38	42	8	0	0	5.4	5.5
Ceramic disc	17	42	29	8	4	0	5.6	4.3
Film	19	27	31	23	0	0	6.7	4.4
Electrolytic	17	34	31	14	4	0	6.3	6.3
Tantalum	19	23	36	19	3	0	7.2	6.3
INDUCTORS	12	24	35	23	6	0	8.6	6.3

Source: *Electronics Purchasing* magazine's survey of buyers

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Electronic Business

An interview with IBM's manufacturing maestros

Outlook 1987: Purchasing strategies for the new year

The revitalization of U.S. electronics manufacturing

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BPA ABP

A yen to make communication equipment in the U.S.

Now that Japanese-manufactured equipment is more expensive, can U.S. companies compete?

Nitsuko Ltd. is a major Japanese manufacturer of telecommunications equipment, with plants in Japan and Taiwan. This company has a yen-based contract with TIE/communications Inc., valid through 1992, making Nitsuko TIE's sole supplier of key telephone systems. Back in 1984, when a dollar bought almost 250 yen, Nitsuko's equipment accounted for 36% of TIE's purchases, and gave the Shelton, Conn. company one of the leading shares of the key telephone systems market. Today, however, a dollar buys only 150 yen, making Nitsuko's equipment far more expensive and, according to TIE's chief executive officer Thomas L. Kelly, Jr., adversely affecting his company's sales and profitability. For the third quarter of 1986, TIE's sales dropped 20% with respect to the previous year.

Conversely, Scientific-Atlanta Inc.'s sales were up 2% for the same quarter. This U.S. manufacturer of earth stations for communication satellites and of telemetry instrumentation has been helped by the demand for more, and more secure, satellite communication equipment and by the weaker dollar. SA's overseas sales for satcom equipment tripled in 1986.

TIE's and SA's business provide a glimpse of the U.S. communication business: the U.S. market continued to grow in 1986 and may do so again this year. Production of communication equipment in the United States did not grow in 1986, but may do so this year thanks to native technology and a more competitive dollar.

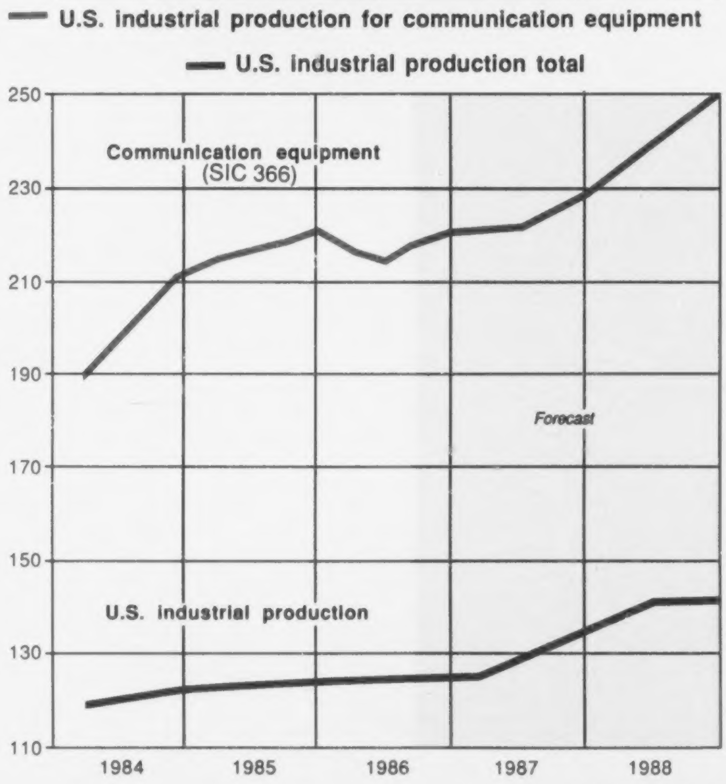
Not much growth, though. Cahners Economics forecasts that, after barely matching 1985's level in 1986, U.S. industrial production of communication equipment (SIC 366) will advance only 3% in 1987. Cahners economist Cheryl Patstone is more optimistic for 1988, forecasting a production growth of 8%.

The U.S. industrial production figures for communication equipment are strongly influenced by the major producer — AT&T — and reflect the production of AT&T's major telephone central office switch: the 5ESS. AT&T has been pushing the production of this switch to stem the inroads in its turf by major competitor Northern Telecom. The company has invested close to a quarter billion dollars in the past three years in Oklahoma City to build one of the most modern electronic assembly lines in the United States. The assembly line was set up for the purpose of manufacturing the 3B20 computer, which goes into the processor of the 5ESS as well as the switches themselves. But now automation is not enough to keep competitors at bay. Some new ones, especially the German telecom giant Siemens AG, have been moving aggressively into AT&T's communications turf. No wonder AT&T is now exploring offshore manufacturing, presumably with better cost protection than TIE got. But such a move by AT&T would keep the production figures from growing at least until 1988.

ALBERTO SOCOLOVSKY

Communication equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders

Manufacturers of electrical machinery received an estimated $49 billion worth of orders in the third quarter of 1986, up from a total of $48.1 billion in the prior quarter. For the first nine months of the year, orders were up 4.4% compared with the same period of 1985. More than 60% of that increase resulted from a pickup in activity in the electronic component, television and radio segments of the industry. Demand for most other types of electrical machinery was running only slightly ahead of year-ago levels, and the communication equipment sector was actually 3.3% below the pace for the first nine months of 1985. All segments are expected to show an improvement in business conditions in 1987, especially during the second half of the year.

Unfilled orders

Manufacturers' order backlogs averaged $84.1 billion in last year's third quarter, unchanged from the level in the prior three months. When final fourth quarter figures become available, the year is expected to show an overall increase of just 2.3% compared with 1985. This will be the weakest annual performance since a mild loss was reported in 1975. Orders have already begun to strengthen in some segments of the electrical machinery industry, and most other areas are expected to see a corresponding turnaround sometime during the current year.

Shipments

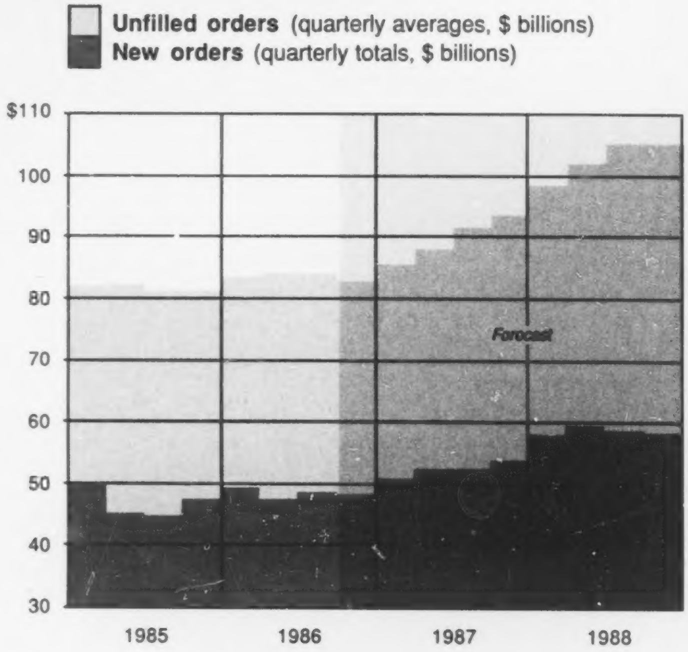
Electrical machinery manufacturers shipped an estimated $49.4 billion worth of products in the third quarter, an increase of 1.6% over the previous quarter and 9.2% over the third quarter of 1985. Gains in the communication equipment, radio and TV segments were responsible for nearly half of the growth in overall industry activity year to date. When final fourth quarter figures become available, industry-wide shipments should post a yearly gain of 4.2% to $193.4 billion. Although demand for military communication equipment has begun to slow recently, other product areas have seen signs of improved customer demand.

Inventory-to-shipments ratio

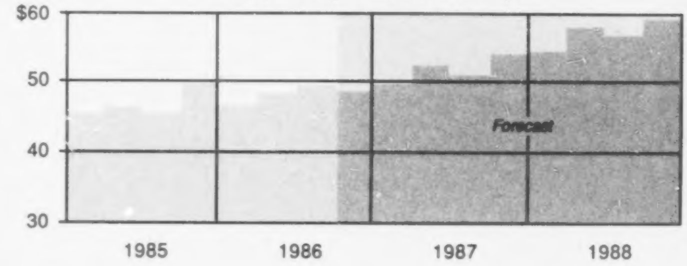
In last year's third quarter, inventories of raw materials, work-in-progress and finished goods, in the electrical machinery industry, rose by 1.7% to an average of $34.6 billion. Because this increase was balanced by a brisk rise in shipments, the industry's inventory-to-shipments (I/S) ratio moved sharply lower. It averaged just 2.07 during the period, down from 2.16 in the second quarter of the year. The latest reading is only slightly above the low of 1.96 reached at the business-cycle peak in early 1984, suggesting that inventory holdings are lean relative to shipments. A brief period of inventory accumulation is expected in early 1987.

Electrical machinery

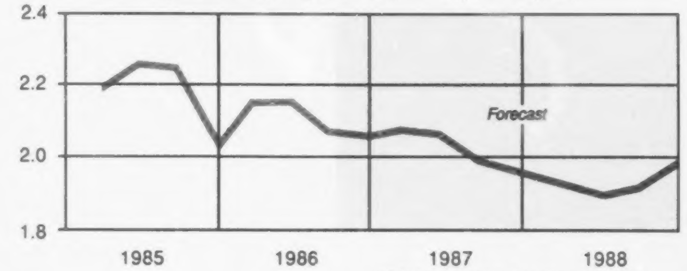
(SIC 36)



Electrical machinery: Shipments
(quarterly totals, $ billions)



Electrical machinery: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Producer price indexes

Electronic components and accessories

Producer prices for electronic components rose 1.0% in the third quarter of 1986, their sharpest increase in 18 months. Price increases, in product areas such as semiconductors and connectors, were responsible for the jump. Most other types of components showed little evidence of upward pressure. Prices are expected to show another moderate uptilt in the fourth quarter, bringing the yearly increase to 2%. This compares with a 2.4% rise in 1985. Accelerating market growth in 1987 and 1988 are expected to cause inflationary pressures to heat up once again. Prices should rise 3% this year and 3.4% in 1988.

Capacitors

Capacitor prices posted their seventh consecutive quarterly decrease in the third quarter of 1986, dipping approximately 1% below the level in the preceding three months. Two factors have been largely responsible for this downtrend: 1) intense global competition, and 2) sluggishness in the major electronic equipment end-user markets, which use capacitors in the production process. Prices are expected to begin moving upward in the fourth quarter, but declines earlier in 1986 will cause prices to fall 2.5% annually, as compared with a 1% drop in 1985. Look for prices to slip merely 0.7% this year and then to increase 1.1% next year.

Resistors

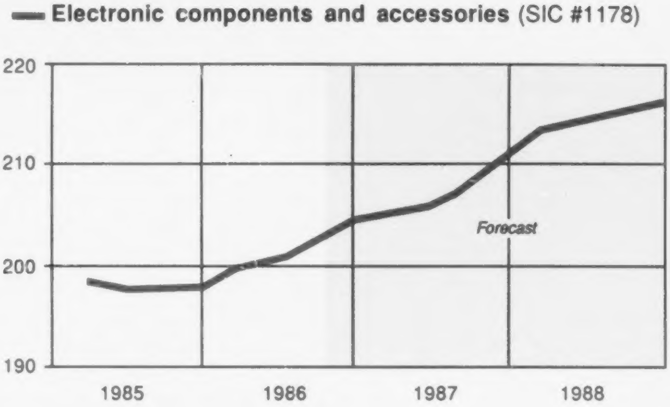
After rising only 0.3% in the second quarter, resistor prices remained unchanged in the third quarter. This leveling off in prices was a reflection of the mid-1986 recession that occurred in most major industrial markets, low domestic inflation rates, and intense competition among resistor manufacturers. Up 2.0% year to date through September, resistor prices are expected to show about the same margin of increase for 1986 as a whole. A moderate rebound in demand this year will cause prices to rise about 2.7% annually. In 1988, look for a 1.1% increase.

Connectors

In the third quarter of 1986, producer prices for connectors jumped 1.3%. This matched the increase reported in the prior quarter but was up sharply from the gains recorded in late 1985 and early 1986. Another rise of about the same magnitude is expected in the fourth quarter; this will push prices up 3.6% annually compared with 1985, the biggest increase in five years. Although demand will be improving in 1987 and the underlying rate of U.S. inflation will be escalating, connector prices are expected to rise less rapidly than they did in 1986, probably 2.5% for the year. An increase of 3.3% should follow in 1988.

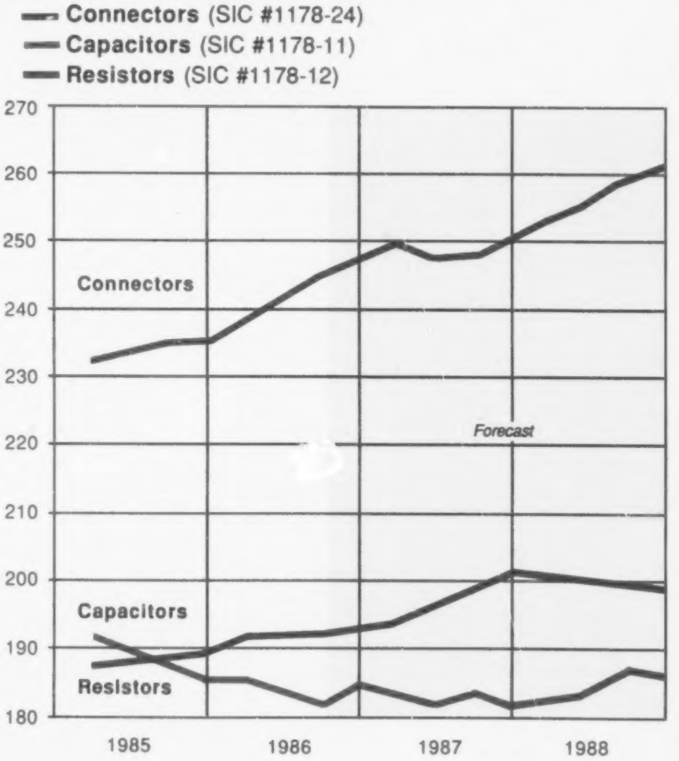
Electronic components

December 1967 = 100, quarterly averages



Passive components

December 1967 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

The Taiwanese government takes steps to aid industry

Like South Korea, Taiwan is trying to focus its efforts so it can continue to make its presence felt overseas

The entrepreneurial spirit is alive and well in Taiwan, and the government is worried. While a handful of South Korean multinationals are making deep inroads in the global electronics market, many in Taiwan, South Korea's chief rival for inexpensive assembly labor, are afraid the island nation may lose its competitive edge.

"In Taiwan, everybody wants to be their own boss," industry officials complain.Unlike South Korea, which has four big electronics-oriented conglomerates, or *chaebols*, linked to the government — Daewoo, Hyundai, Lucky-Goldstar and Samsung — Taiwan's $8 billion electronics industry consists of 2,300 mainly small, family-owned companies. Competing for Western original equipment manufacturers' (OEM) contracts, the Taiwanese electronics firms also frequently undercut each other's pricing, ensuring that no one company ever gets too big.

"South Korea is one-third the size of Taiwan [in area and half the size in population], but it has three car manufacturers, and we have eight. That ought to tell you something about competition in this country," says George Lie, an executive at Ching Fong Investment Co., a Taiwanese holding company which manages a portfolio of companies, including a local venture capital firm; Cogito U.S.A., a San Jose, Calif., disk drive manufacturer; and Sanyan Industry Co., a $250 million a year auto maker.

Jumping ship

Being small, most Taiwanese companies many times do not have the manufacturing, advertising and promotion budgets to effectively penetrate foreign markets the way the Korean *chaebols* can. "It's much easier to penetrate the European market than it is the States'," adds Simon J. Hsieh, manager of market planning for Microtek International Inc., makers of microcomputer in-circuit emulators. "It costs a lot of money to get your message out in the U.S."

In addition, managers in Taiwan often jump ship to form new companies, at a rate that would even make the heads spin of Silicon Valley's notorious job-jumpers. IBM and Apple Computer Inc. have teamed up to use their political, economic and legal clout to stop computer piracy. But with an average per capita income of $3,000, it is still easy to find cheap labor in Taiwan to build look-alike products.

To stablize the situation and instill some measure of centralized planning, the Taiwanese government is taking steps to protect the island's position as a low-cost supplier to the United States, Europe and Japan. Six years ago, the government set up the Science-Based Industrial Park in Hsinchu, near Taipei, to act as a home base for Taiwan's high-tech industries. Firms in the park work closely with the state-run Electronics Research and Service Organization to develop state-of-the-art Tawainese products.

More recently, the Institute for Information Industry, a quasi-governmental agency, hired market research firm Arthur D. Little Inc. in Cambridge, Mass., to identify key strategic areas for Taiwanese electronics manufacturers. A. D. Little singled out nine areas for the island to concentrate on — including (in software) business applications, expert systems and scientific applications; and (in hardware) facsimile machines, intelligent terminals, nonimpact printers, multifunctional workstations, Winchester disk drives and private branch exchanges.

Made in Taiwan

The government is also now encouraging Taiwanese firms to sell directly into Western countries under their own names, rather than private-label products. "We build products for all the major manufacturers — including IBM — but too often our products only show up in America with the words, 'Made in Taiwan' on them," says Irving T. Ho, president of the Institute for Information Industry. "So we're trying to convince our industry to also sell under our own brand names, to build brand awareness in foreign markets. Only in this way can we control our own destiny."

Brand awareness is also important because Tawian is afraid that rising protectionism in the United States, aimed primarily against Japan, could spill over into higher U.S. import tariffs for Taiwanese electronics equip-

Joseph Rupp

INSTITUTE OF INFORMATION INDUSTRY's HO: Taiwan must control its own destiny

Taiwan's widening trade deficit with the U.S.

($ billions)

	Imports	Exports
1981	$4.305	$8.049
1982	4.367	8.893
1983	4.667	11.204
1984	5.003	14.768
1985	4.700	16.396
1986	3.842	14.462

Source: U.S. Department of Commerce

ment. The U.S. trade deficit with Taiwan is now about $1 billion a month, primarily due to Taiwan's footwear and textile exports. But it is only a matter of time before America's beleaguered electronics industry also starts to complain, even though half of Taiwan's electronics output involves sales for captive operations for Digital Equipment Corp., IBM, Wang Laboratories Inc. and other U.S. manufacturers.

Meanwhile, though, Taiwan's annual trade surpluses are swelling Taiwan's foreign exchange reserves to $26 billion, making it easier for the country to offer incentives to emerging high-tech companies. The government, for example, can now purchase up to 49% of any start-up targeting what the government considers a strategic technology.

But it will take more than money to crack the U.S. market, as so many European electronics firms have learned in their unsuccessful efforts to grab a toehold in the United States. So Taiwanese companies are also taking a page from the Korean's book and starting to hire Americans to run their U.S. marketing and distribution operations. Mitac International Corp., for example, a $120 million a year personal computer maker, recently set up shop in Santa Clara, Calif., to sell its new line of IBM PC AT, and PC XT compatibles. As director of marketing, Mitac chose Philip D. Wood. Wood formerly worked for Leading Edge Hardware Products Inc. in Canton, Mass., a leading U.S. distributor of Daewoo personal computers.

AL FURST

Chip makers better keep TABs on their VLSI designs

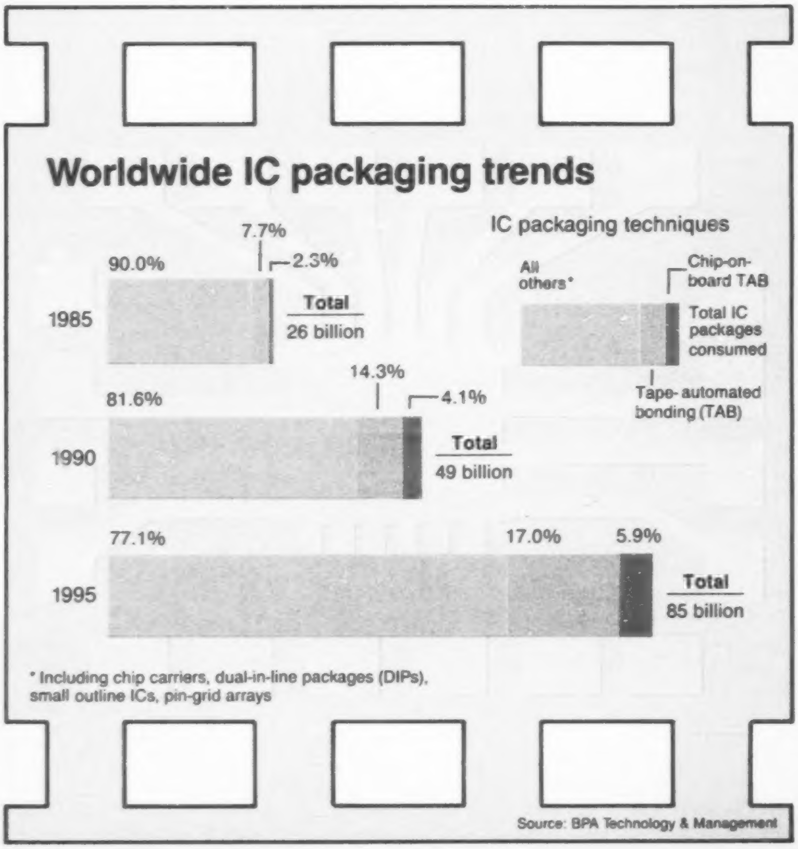
Semiconductor companies have spent a lot of money perfecting IC fabrication. It's time they invested in packaging

The next great frontier in microelectronics may well be development of the low cost, high reliability, high pin-count package. One trailblazer already has appeared on the horizon — tape automated bonding (TAB), a packaging technology expected to be in much wider use by the end of the decade.

One out of every seven integrated circuits built in 1990, industry observers predict, will be packaged using TAB — double its use in 1985. Such demand, in turn, is expected to spur demand for TAB materials, equipment and prototyping services — a nascent market currently sized anywhere between $25 million and $35 million.

What is driving IC manufacturers toward TAB technology are the limits of conventional packaging techniques. The very large scale integration (VLSI) devices being developed by those manufacturers demand superior packages — ones that can dissipate the heat and solve the other problems created by their new IC designs.

"The package is the real challenge," insists Harvey Miller of Kirk-Miller Associates, a market research firm in Palo Alto, Calif. Less challenging, he argues, is the actual fabrication of the integrated circuit — despite all the attention given to it. "With all due respect to the front-end process," Miller says, "gains there mean nothing if you can't produce packages that can carry away all the heat, allow for testing and provide interconnection of



Worldwide IC packaging trends

* Including chip carriers, dual-in-line packages (DIPs), small outline ICs, pin-grid arrays

Source: BPA Technology & Management

hundreds of leads, and do all this economically."

"The implementation of a high-performance package deserves a hell of a lot more attention," agrees Brian Hegarty, vice president and general manager of Honeywell Inc.'s Solid State Electronics Division in Colorado Springs, Colo. "The package limitations always define the [performance] limits of the device itself."

New generation packages

An IC package encases or surrounds a chip of silicon on which the integrated circuit is etched. Besides protecting the chip and dissipating its heat, the package serves to connect the device to a printed circuit board.

Today's prevalent packaging technology — the so-called dual in-line package (DIP) — involves attaching the individual chip to a "leadframe" strip (substrate) and using a gold wire bond to connect the leads of the IC to the frame. This assembly is then encapsulated in epoxy, and, after the leadframe is separated from the strip, the leads are formed. These leads provide connection of the assembled device to the outside world.

In the TAB process, however, the wire bonding step is eliminated. Essentially, "bumps," or elevated interconnection pads on the chip, are bonded with a simple heating tool to copper conductors on a leadframe. A so-called chip-on-board assembly is easily effected by connecting those copper conductors to the copper traces on a printed circuit board.

The advantages of TAB in certain applications — both low (14- and 16-lead) and high (80 and up) pin count — are numerous. For commodity devices such as memory ICs used in cars, the elimination of the intermediate wire bonding step allows for higher throughputs and ease of automation. National Semiconductor Corp. pioneered this application over a decade ago and last fall licensed its TAB technology to General Motors Corp.'s Delco Division. For more complex devices, TAB offers still greater technical advantages: lower inductance (and therefore a cleaner, faster signal); smaller bond pad size, a key to saving silicon space; shorter lead lengths (which makes TAB ideal for applications requiring flatness, such as "smart" cards); and the ability to ensure separation of the leads, a crucial factor when the leads number 200 or more.

TAB packaging was used on about 2 billion ICs in 1985 — representing 7.7% of the 26 billion ICs produced worldwide that year, estimates BPA Technology & Management, a Britain-based research firm. TAB use will grow to about 7 billion packages by 1990 — accounting for 14% of the total market, according to BPA. The use of TAB in chip-on-board assembly will more than triple in that time from 600 million devices in 1985 to 2 billion in 1990.

Smart cards will probably be the single biggest commercial application. Demand for these intelligent credit and security cards is expected to create a market for 500 million chip sets a year by 1990 in the United States, according to Smart Card Reports, an industry newsletter [ELECTRONIC BUSINESS, June 15, 1986 p26]. The first smart cards on the market do not offer enough functionality to require high lead-count TAB, but nearly all observers agree TAB will be necessary if smart cards are to achieve high-level intelligence.

> TAB use will grow to about 7 million packages by 1990 accounting for 14% of the total market

International Micro Industries (IMI), a $4 million supplier of etched tape and equipment for TAB, three years ago spun out a new company, Smart Card Systems Inc., in an effort to vertically integrate. The spinoff already is bidding on a Department of Agriculture contract for 100,000 cards and is negotiating a marketing deal with a military contractor.

Thomas Angelucci, president of Cherry Hill, New Jersey-based IMI and the founder of Smart Card Systems, firmly believes he can leverage IMI's 16-year TAB history into the smart card business. "The office automation companies making smart cards don't understand the packaging," he claims. "We believe our multi-TAB packaging system can save $1 to $1.50 on each card, and we can realize additional savings by utilizing commercially available NMOS [negative-channel metal-oxide semiconductors] devices."

Meanwhile, the 1986 worldwide market for TAB materials, equipment and prototyping services is estimated at no more than $25 million to $35 million. In addition to IMI, U.S. materials suppliers include Minnesota Mining and Manufacturing (3M) Co. and Rogers Corp., which supply unetched tape; Olin Corp.'s Mesa Technology Unit; Micro Bond Technologies, a unit of Gould Inc.; and Koltron Corp., acquired earlier this year by Nippon Mining & Manufacturing of Japan. Mesa also markets TAB hardware from Siemens AG. Jade Corp. in Pennsylvania, the Swiss firm Farco SA, and the Japanese Shinkawa Ltd. are among those supplying equipment for gang bonding, soldering and handling TAB packages.

Major suppliers

Their customer base, however, has grown to at least several dozen. In addition to National Semiconductor, which has made by far the largest commitment to TAB, such merchant IC manufacturers as Fairchild Semiconductor Corp., Honeywell and VTC Inc. have made significant investments. The list of giant captive IC suppliers experimenting with TAB is much longer. It includes Apple Computer Inc., Cray Research Inc., Digital Equipment Corp., Ford Motor Corp., General Motors Corp., IBM and Unisys Corp. Areas in which high speed is important — supercomputers, advanced military silicon and gallium arsenide circuits — are the most fertile captive breeding grounds for TAB.

Nevertheless, some complain that the pace could be faster. "I don't see the big market they're talking about," says Larry Barber, a TAB product manager at Koltron. "There is a great deal of inertia out there, and the (TAB) technology is not proven in high volume for high lead-count devices."

A more prevalent view comes from Charles Turk, the president of Mesa. He is aiming at the TAB markets starting to emerge for high lead-count devices for gate arrays and very high speed integrated circuit (VHSIC) chips; for chip-on-board systems applications in Europe and Japan; and multichip packages.

"Don't make the traditional mistake of looking at the low-end cost-driven business as the real market," Turk cautions, speaking from experience. Mesa's original goal was to become a second source to 3M at National, but the start-up failed to get National's business. The misstep did not sour the Mesa executive on TAB, however. "If you can sell solutions to interconnect problems and not just tape or equipment," Turk says, "the potential is enormous."

MARK MEHLER

Dialing for dollars in the key telephone system market

Companies that can afford to manufacture in house or cut unnecessary distribution tiers may fare better than others

Today's $1 billion U.S. market for key telephone systems (KTS) — business telephone systems that offer special features — is no place for the faint hearted. The industry comes replete with all of the headaches of a commodity market — intense price pressures, slim profit margins and brutal competition.

"Because the market is so cost driven, a lot of interim levels of distribution are being squeezed out," notes Francis McInerney, analyst with New York City-based research firm Northern Business Information Inc. (NBI). To survive, McInerney suggests, vendors must be able to cut costs, either by manufacturing in house or by eliminating some levels of distribution costs.

Market leader AT&T has done well, for example, because of the company's tremendous strength in manufacturing expertise. The telecommunication equipment titan "has been able to develop very advanced and flexible automation," which, in turn, has allowed them to keep costs down, McInerney says. Although unit shipments by AT&T slipped slightly — to an estimated 1.1 million stations in 1985, down from 1.2 million stations in 1984 — McInerney believes that, in general, the company will be able to "hold steady" in a market expected to decline to $625 million in sales by 1990.

Toshiba is another player doing well. Paul Wexler, vice president and general manager for Toshiba America Inc.'s Telecommunication Systems Division in Tustin, Calif., attributes Toshiba's continued health to two factors. "We spend probably more time on distribution channels than on anything else," he says, and "95% or more of our product content is Toshiba-sourced."

Shipments at Toshiba increased 45%, from 238,000 to 346,000, between 1984 and 1985, according to NBI estimates. Although Wexler does "not see the same growth in 1986 as in 1985," he does expect that once 1986 shipments are totaled, Toshiba's growth will be in the single digits, and will be significant. He also expects 1987 growth will be in the "same order of magnitude as 1986."

Customer focus

Very few key telephone system vendors, however, are in a position to make their own products. To prosper, they need to emphasize close customer ties. For example, ISOETECH Communications Inc., based in Darien, Conn., expects to post $60 million to $65 million in 1986 by emphasizing its distribution channels. Charles D. Kennedy, vice president of marketing, says the firm now has 11 direct sales offices and 29 exclusive regional distributors across the country. And outside the United States and Canada, Sweden's Ericsson Information Systems Communications Division will market ISOETECH gear under the Ericsson label. ISOETECH's concern with the customer's needs is what sold INMAC Corp. on ISOETECH equipment, says Bill Sultan, western regional manager of the computer and accessories catalog firm in Santa Clara, Calif. "We wanted someone flexible enough to change their programs to meet our needs," says Sultan, and "they spent a lot of time trying to understand our needs."

Another start-up that NBI's McInerney expects will do well is Shared Resource Exchange Inc. (SRX), based in Dallas. SRX manufactures its two product lines — key systems and private branch exchange (PBX) equipment — in the United States and it has distribution agreements with independent telephone companies and regional interconnects. SRX president, Eric L. Jones, is predicting 1987 shipments to be "about three times that of 1986." Last year, which was the company's first full year of shipping product, SRX shipped approximately 300 systems, according to Jones.

Pitfalls

For many manufacturers, however, the last few years have not been fun. The market's No. 2 sales performer in 1985, for example, — TIE/Communications Inc., based in Shelton, Conn., — suffered a loss of $10.9 million during the first nine months of 1986. In 1985, the company racked up a loss of $75 million. Unit shipments also declined to 750,000 in 1985, down from 1.037 million unit shipments in 1984, according to NBI estimates.

TIE, which at press time had not responded to repeated phone calls, has tried to get back on track in several ways. The company has purchased two equipment makers, Plessey Canada Ltd. and Turret Equipment Corp.; signed distribution agreements with all seven regional Bell operating companies (RBOCs); merged with distributor Technicom International Inc.; and acquired HCL Leasing Corp., a leasing firm that has since been sold. "Trying to move in too many ways at once killed the goose that laid the golden egg," NBI's McInerney says.

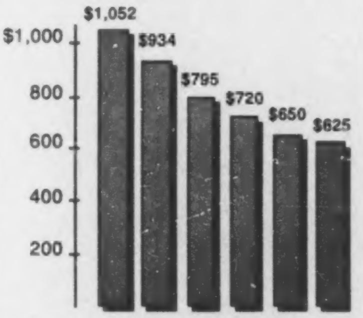
This confusing strategy has also trickled down to TIE's distribution channels. According to a former TIE distributor, Robert Hendershott, president of All-Tel Business Communications Inc., based in Kalispell, Mont., TIE "changed product too often for us to be able to keep up on it." As a result, Hendershott says that he "gave up on [distributing] TIE [products], and won't go back."

Overall, McInerney foresees 1987 as a "brutal" year for KTS vendors. The newer companies, he says, are being run by "real tough guys [who] are out to kill [and] the others, who aren't out to kill, will get killed."

CAROL SUBY

The U.S. key telephone systems market suffers a money crunch

Market size* ($ millions)



* Based on stations shipped

Source: Northern Business Information Inc.'s estimates

The new Congress takes another look at trade

With a $12 billion electronics trade deficit worldwide and a $20 billion deficit with Japan, the U.S. is looking for relief

As the new 100th Congress gets its house in order, the competitive stance of U.S. business is expected to be a key issue.

The U.S. balance of trade for electronic products and services continued to worsen through the first half of 1986. Assuming that the trade balance continued at the same rate for the second half, the U.S. deficit with the world was expected to exceed $12 billion and the deficit with Japan was projected to reach $20 billion, according to the American Electronics Association (AEA). In 1980, the electronics industry had a positive trade balance of $7.4 billion with the world and a negative trade balance with Japan of $3.9 billion.

The first step toward reversing the deteriorating condition of U.S. competitiveness is passage of a trade bill, according to Representative Jim Wright (D-Texas), majority leader of the House of Representatives. Wright says the House will start by introducing as H.R. 3 the omnibus trade bill passed by the House (but not the Senate) last year. The House vote was a bipartisan 295-115, despite the Reagan administration's opposition on some key portions of the bill.

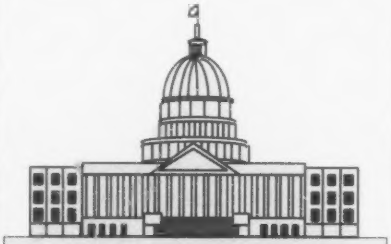
Now that the Democrats have wrested control of the Senate from the Republicans, the trade bill stands a better chance of approval. It remains unclear, however, what changes will be made before the proposed legislation makes it to the Senate floor.

The trade bill is not the only legislation expected to have an effect on electronics-related companies. Technical amendments to last year's massive tax reform bill also will be considered by the new Congress. It is not clear exactly what legislation will be introduced, but industry officials will be watching closely.

On the defense

The final tax reform bill that emerged in late summer was generally considered to be positive for the industry. While "loss of the capital gains differential is a negative," according to the AEA, "preservation of the research and development tax credit — albeit at a lower rate — will help many AEA companies, as will the preservation of export incentives and recognition of the short life of high-tech equipment for depreciation." And reduction of the overall corporate tax rate also is expected to benefit the industry.

Defense firms are waiting to see what the long-term impact of the Gramm-Rudman budget-balancing law will be on procurement. Early signs are that it will slow Pentagon acquisitions and eliminate some major programs. "Our members have seen some impact from Gramm-Rudman and they are expecting that it will accelerate," says Peter McCloskey, president of the Electronic Industries Association (EIA). "The 10-year forecast for defense electronics shows at most 2% annual growth."



The rising U.S. trade deficit in electronics products

($ billions)

	Exports	Imports	Balance
1981	$25.3	$19.3	+ $6.0
1982	26.0	21.0	+ 5.0
1983	27.9	26.7	+ 1.2
1984	32.8	39.0	- 6.2
1985	35.6	44.5	- 8.9
1986*	37.0	49.0	- 12.0

* ELECTRONIC BUSINESS estimate

Source: American Electronics Association

Congress, meanwhile, approved a $292 billion fiscal 1987 Defense Department budget as it raced to adjourn the 99th Congress. A compromise between earlier House and Senate bills, the defense authorization is about $28 billion lower than the Reagan Administration originally requested, but still slightly higher than the fiscal 1986 appropriation. Strategic Defense Initiative funding was held to $3.53 billion, significantly less than the $5.3 billion sought by the administration.

Computer and software firms anticipate introduction of several key bills relating to their industries. One bill, for example, would establish the Information Age Commission to consider the impact of computer and communications systems on society and act as a catalyst for change where necessary. The Information Age Commission passed the Senate but ran out of time in the House during the 99th Congress.

Software piracy

"It advocates a more comprehensive review of computer-related issues than the piecemeal approach of Congress so far," says Olga Grkavac, vice president, government relations of the Association of Data Processing Service Organization (ADAPSO). The Information Age Commission would create a forum for discussing such matters as intellectual property rights, computer education, computer crime and privacy.

ADAPSO also expects a software rental bill to be introduced next year. That bill would clarify laws preventing individuals from renting and illegally copying software. "Thou shalt not dupe" has become ADAPSO's motto, as the industry association struggles to protect intellectual property rights both nationally and internationally.

It remains uncertain just how much of an impact Democratic control of the Senate will have on important issues. "The key to what happens next are the economic numbers, not who controls the Senate," according to Susan Simon, a political analyst for E.F. Hutton. "For example, suppose the trade deficit [now at about $14 billion a month] heads back over $15 billion a month, then the newly elected will have to say or do something. They'll say, 'We have to pass a bill and take *ad hoc* protectionist action like we did in lumber and semiconductors.'"

BETH KARLIN

Equipment makers buy new designs, not new rules

Computer and communications companies are willing to invest in new chip technologies. But they'd prefer to unload trade laws

By Tim Mead and Nancy McSharry

Heading into 1987, U.S. computer and communications companies are confident in the economy, uncertain about the new tax law and critical of trade barriers.

They will keep the bulk of their manufacturing onshore and in house. They will spend little more on semiconductor-related capital equipment. And they will dramatically increase their use of surface-mount technology (SMT).

Makers of minicomputers, multiplexers and the like also will buy 32-bit microprocessors in droves. They will design more custom integrated circuits into their systems. And they will take advantage of the performance characteristics of programmable memories.

Those trends and others emerged in a survey of engineering, production and operations managers conducted in late November by ELECTRONIC BUSINESS. The magazine focused on managers in U.S. computer and communications manufacturers because they buy half of all the electronic components sold in the United States. It narrowed its component-specific questions to semiconductors for the very same reason — they account for half the components purchased by U.S. equipment producers.

Macroeconomic views

Few surprises emerge when managers are asked how they view the general economy this year. Most are either optimistic (49%) or at least neutral (44%) about where the economy will head in 1987. A very small number (7%) actually believe it will decline.

Their opinions on the new tax law are mixed — but certainly not on the positive side. Only 6% of computer and communications executives actually believe the legislation will improve their companies' capital spending on plant and equipment. Fully 34% of them believe the law will have a negative impact, slightly less than the percentage (38%) who think the law will have no effect on such spending. An astounding 22% have no opinion whatsoever on the impact of tax reform.

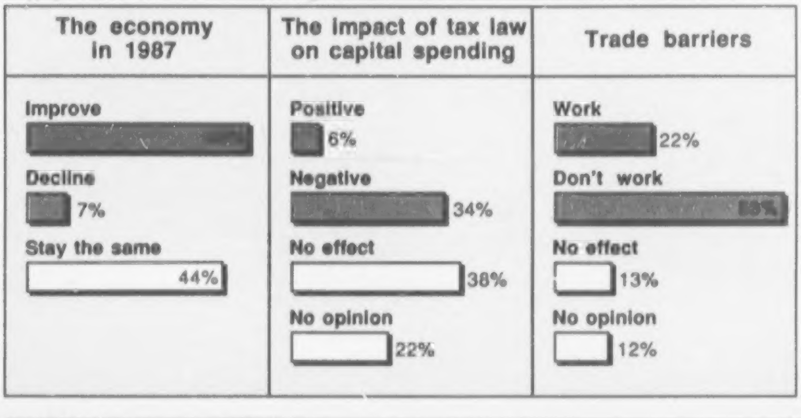
Government-imposed trade barriers do, however, elicit strong reactions from managers. More than half (53%) say such barriers don't work; only 22% believe they do. The remaining 25% either think trade restrictions have no impact or offer no opinion on the subject.

Most revealing, perhaps, is how much manufacturing will remain on U.S. soil and in the hands of the companies themselves. Managers at computer companies indicate that nearly 75% of the printed circuit boards (PCBs) used in their systems will be stuffed with components in the United States. Their communications counterparts have even closer ties to U.S. assembly, saying 85% of the finished PCBs that go into their products will bear the "Made in the U.S.A." label.

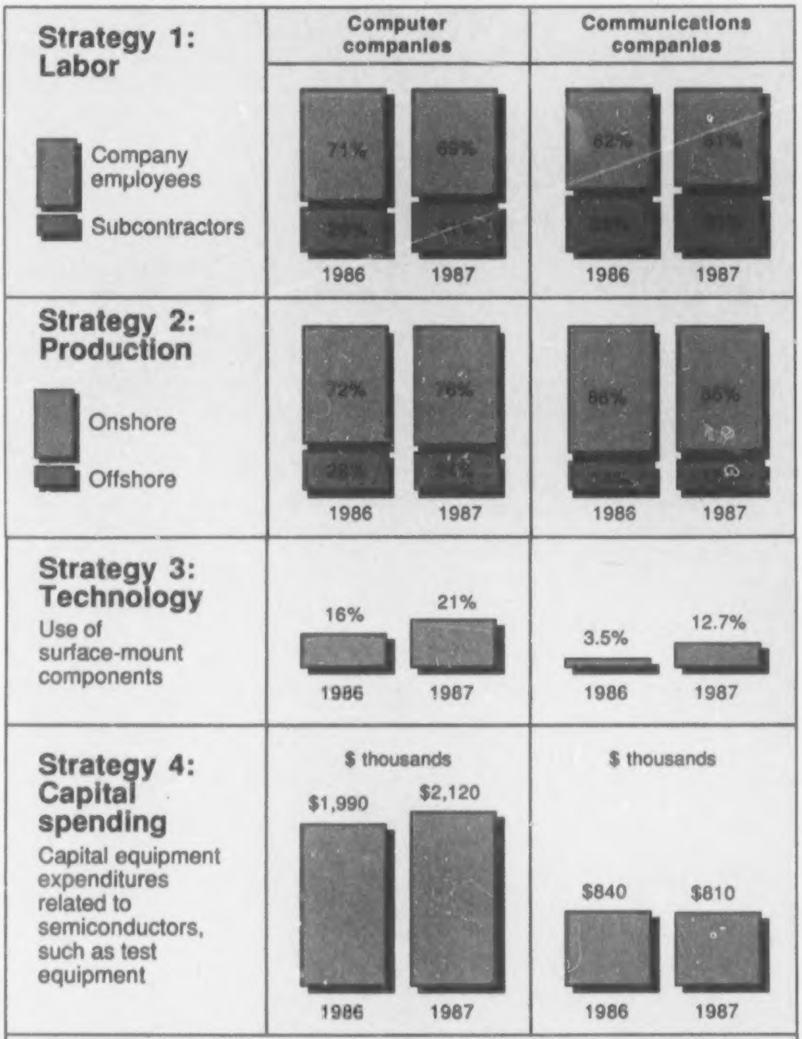
Both types of equipment makers will continue to produce the majority of their goods at their own factories. But somewhat surprisingly, manufacturers of datacommunications and telecommunications equipment are using subcontractors more than computer makers. Nearly 40% of the finished PCBs that go into modems and other types of communications gear come from subcontractors. Only 30% of those in computers are supplied by outsiders.

Despite the fact that 60% to 70% of manufacturing will remain within companies in 1987, they are not planning to significantly increase spending on semiconductor-related equipment.

An opinionated bunch— What managers at computer and communications companies think about:



Manufacturing strategies differ in degree, but computer and communications companies agree in substance



Expenditures are for an average company in each category. The average size of a computer company responding to the survey was $1 billion or higher in revenue. The average size of a communications company ranged between $50 million and $500 million in revenue.

The average computer company's outlay on such equipment will increase 7% this year, while the average communications company's spending actually may decline 4%. Such behavior is understandable, given that most computer and communications companies are now only using 70% of their existing manufacturing capacity. The loss of the investment tax credit, part of the new tax law, also is curbing capital spending.

One class of capital equipment that computer and communications companies will certainly buy, regardless of plant utilization or tax reform, is machinery used in conjunction with surface-mounted components. Computer managers expect that 21% of the semiconductors they use this year to be in SMT form — up from 16% last year. Their communications peers have somewhat lower expectations: Only 12.7% of the semiconductors they use are to be in SMT form in 1987 — up from 3.5% in 1986. SMT equipment makers would be wise to focus on computer and communications accounts with sales in excess of $50 million. Companies of such stature indicate the greatest willingness to use surface-mounted components.

What's hot, what's not

The "in" chip for 1987 is the 32-bit microprocessor. Nearly nine out of 10 managers (89%) at personal computer manufacturers indicate that their companies intend to use more 32-bit MPUs in 1987 than in 1986 — a statistic no doubt buoyed by the availability of Intel Corp.'s 80386 microprocessor. Interestingly, however, the popularity of 32-bit chips among PC makers will *not* be at the expense of 16-bit devices. Nearly as many managers (86%) say their companies plan to use more 16-bit MPUs this year than last; none of them say they intend to use fewer 16-bit chips in 1987.

There is evidence that 32-bit microprocessors will cannibalize 16-bit chip sales to manufacturers of board-level computers, workstations and minicomputer makers. Almost 10% of the managers at board-level computer makers plan to use fewer 16-bit products in 1987, while 75% of them intend to use more 32-bit chips. More than 20% of the managers at workstation and minicomputer companies say they will reduce their use of 16-bit MPUs this year; 75% of them, however, will use more 32-bit designs.

Communications companies also are eager to capture the power of 32-bit MPUs and their 16-bit predecessors. All of the managers at multiplexer, network, private-branch exchange, and central-office switch vendors indicate their companies will use at least 100% more 32-bit devices this year. And almost all of them plan on increasing the use of 16-bit chips by at least 50%.

Along with increased processing power comes demand for more sophisticated ways of managing memory. At least half of the managers in all five of the survey's computer categories indicate their companies will use more electrically erasable programmable read-only memories (EEPROMs) and simple EPROMs in 1987 than in 1986. Dynamic and static random-access memories (DRAMs and SRAMs) also will enjoy new popularity this year. In one category alone, minicomputer companies, as many as eight out of 10 managers say they'll use more DRAMs.

Semiconductor buying analysis
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- Communications companies page 74

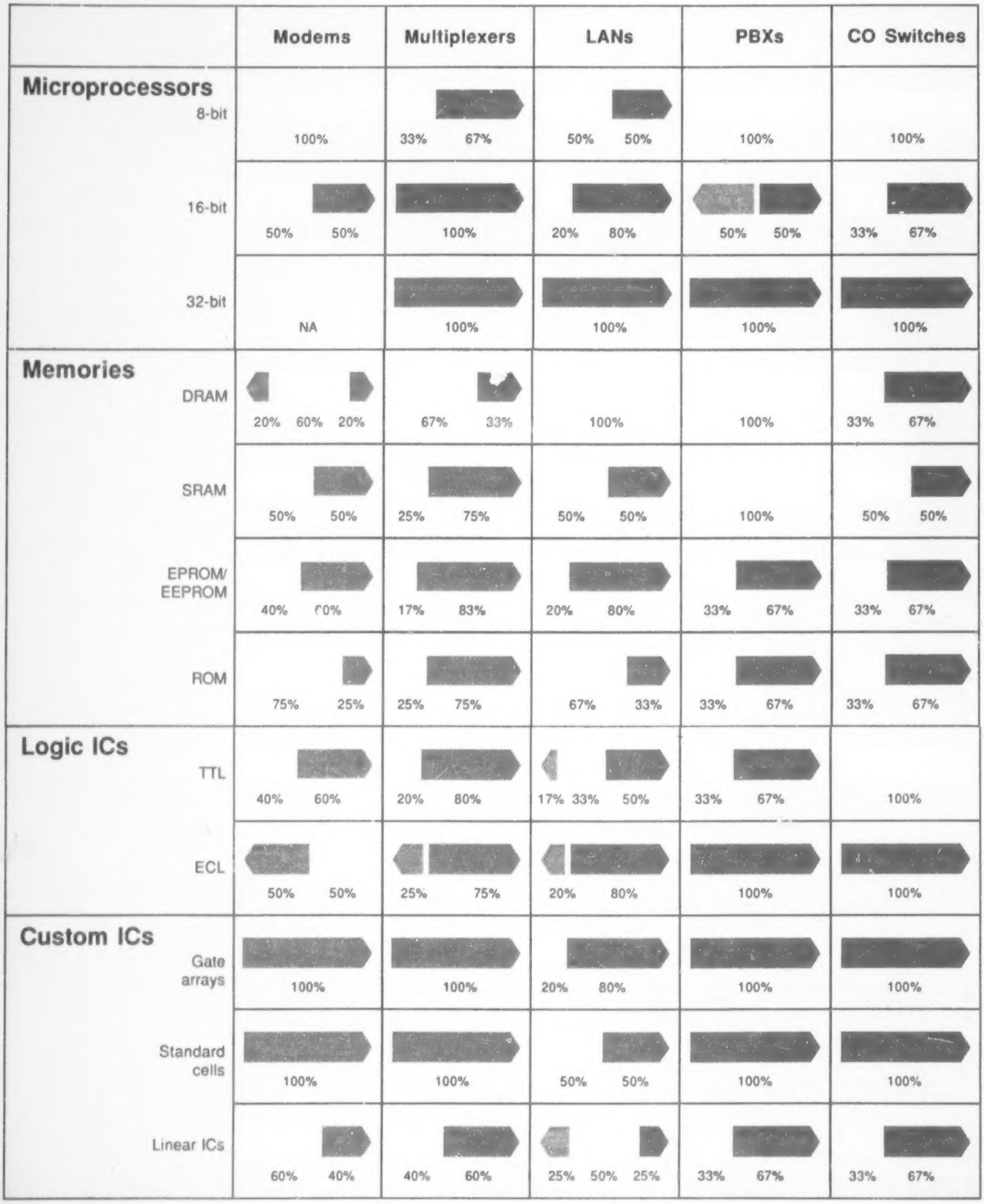
Computer companies: Will they use less, the same amount of, or more components?

◀ Less ☐ Same ▶ More

	Board-level computers			PCs			Work-stations			Minis			Mainframes		
	Less	Same	More	Less	Same	More	Less	Same	More	Less	Same	More	Less	Same	More
Microprocessors															
8-bit	75%	13%	12%	60%	20%	20%		67%	33%	50%		50%	100%		
16-bit	9%	36%	55%		14%	86%	23%	6%	71%	28%	28%	44%		50%	50%
32-bit		25%	75%		11%	89%		25%	75%		25%	75%	12%	25%	63%
Memories															
DRAM		50%	50%		23%	77%		29%	71%		17%	83%		25%	75%
SRAM	14%	43%	43%		29%	71%		40%	60%		25%	75%		25%	75%
EPROM/ EEPROM	9%	18%	73%	10%	30%	60%	10%	30%	60%	20%	20%	60%	25%	25%	50%
ROM	11%	33%	56%		50%	50%		40%	60%	20%	40%	40%	25%	25%	50%
Logic ICs															
TTL	14%	29%	57%	18%	16%	66%		22%	78%	40%	20%	40%	50%	25%	25%
ECL	25%	50%	25%	25%	25%	50%		20%	80%		25%	75%		25%	75%
Custom ICs															
Gate arrays		37%	63%	11%	22%	67%		18%	82%			100%		20%	80%
Standard cells		50%	50%	14%	29%	57%	24%	13%	63%	25%	25%	50%		33%	67%
Linear ICs	16%	67%	17%	28%	43%	29%	11%	56%	33%	20%	60%	20%		67%	33%

Communications companies: Will they use less, the same amount of, or more components?

Less Same More



		Modems	Multiplexers	LANs	PBXs	CO Switches
Microprocessors	8-bit	100%	33% 67%	50% 50%	100%	100%
	16-bit	50% 50%	100%	20% 80%	50% 50%	33% 67%
	32-bit	NA	100%	100%	100%	100%
Memories	DRAM	20% 60% 20%	67% 33%	100%	100%	33% 67%
	SRAM	50% 50%	25% 75%	50% 50%	100%	50% 50%
	EPROM/ EEPROM	40% 60%	17% 83%	20% 80%	33% 67%	33% 67%
	ROM	75% 25%	25% 75%	67% 33%	33% 67%	33% 67%
Logic ICs	TTL	40% 60%	20% 80%	17% 33% 50%	33% 67%	100%
	ECL	50% 50%	25% 75%	20% 80%	100%	100%
Custom ICs	Gate arrays	100%	100%	20% 80%	100%	100%
	Standard cells	100%	100%	50% 50%	100%	100%
	Linear ICs	60% 40%	40% 60%	25% 50% 25%	33% 67%	33% 67%

The bus battle moves to a 32-bit arena

The board-level market continues to bristle with competing bus structures as it surpasses $1 billion in sales

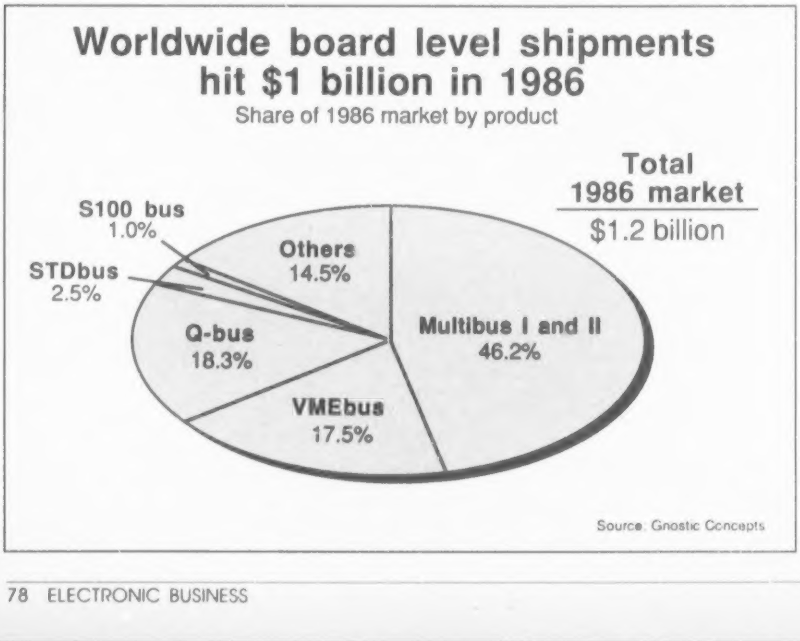
By Anne Knowles

Ever since 32-bit microprocessors became a reality, industry watchers have been waiting for the battle between 32-bit buses to begin. In one corner, say observers, stands Motorola Corp., maker of the 32-bit 68020 chip and developer of VMEbus, the leading 32-bit bus architecture. In the opposite corner is Intel Corp., manufacturer of the 80386 microprocessor and designer of Multibus II. And in the middle is a billion-dollar business.

That billion-dollar business is board-level microcomputer products, which Gnostic Concepts Inc., a market research firm in San Mateo, Calif., estimates reached $1.2 billion in worldwide revenue last year. Hundreds of vendors sell board-level products based on standard bus architectures — the network of connections that link components across a board. Some sell central processing unit (CPU) boards using off-the-shelf microprocessors and open bus structures. Others market add-on boards, such as input/output boards, that are compatible with leading bus architectures, such as Q-bus, Digital Equipment Corp.'s 16-bit bus structure.

In the 16-bit board-level world, DEC's Q-bus and Intel Corp.'s Multibus I are the leading contenders. The two bus architectures have captured about 80% of the 16-bit board-level market between them. "We've seen a lot of buses come and go," says Robert Hughes, executive director of the Multibus Manufacturers Association, in Portland, Ore. The reason for the historical dominance of the two bus architectures, says Hughes, is that most board-level vendors choose a standard that is being ported by at least one major manufacturer.

> At stake for Motorola and Intel is more than just a pledge of loyalty from a handful of vendors



Worldwide board level shipments hit $1 billion in 1986

Share of 1986 market by product

Source: Gnostic Concepts

Because of that, observers expect the same shakedown to occur in the maturing 32-bit market. Futurebus, a 32-bit bus developed and promoted by the Institute of Electrical and Electronic Engineers; and NuBus, designed at Massachusetts Institute of Technology, further developed by Western Digital Corp. and acquired by Texas Instruments for its Nu Machine; lack the corporate backing, says Hughes, to gain much market share.

DEC's 32-bit BIbus, announced last year, certainly has the support it needs. But most analysts say it will not have an effect on the war between open bus structures. "Very few vendors would think of doing board-level products," based on DEC's BIbus, says Robert Herwick, an analyst with Hambrecht & Quist in New York City. And for its part, says Hughes, DEC is not interested in attracting board-level competitors.

Most board-level vendors, say observers, will choose between Motorola's VMEbus and Intel's Multibus II, two open 32-bit bus architectures backed by major microprocessor makers. What has yet to be determined is which bus structure will come out on top.

At stake for Motorola and Intel is more than just a pledge of loyalty from a handful of vendors. Some argue that bus architectures sell microprocessors, microprocessors sell bus structures and so on. "Certainly the more 80386s sold, the more Multibus IIs sold," says Hughes. And the more vendors that support Multibus II, the more Intel can sell 32-bit chips, says Hughes.

That may partially explain why, to date, there has not been much of a 32-bit bus battle. VMEbus, designed by Motorola, Mostek, Philips/Signetics and Thompson CSF and introduced in late 1981, has captured the lion's share of the nascent 32-bit board-level market. Over 120 vendors manufacturing over 600 products sell VMEbus-based boards, while only about 75 manufacturers making 130 different boards sell Multibus II-based products.

Motorola also has leading market share in the 32-bit microprocessor market. In 1985, according to Dataquest Inc., a market research firm in San Jose, Calif., Motorola's 68020 garnered 60% of the $16.8 million market for 32-bit microprocessors. But a year later, and a year after Intel's 80386 was unveiled, Motorola's share of the 32-bit microprocessor market shrunk to 50% while Intel appeared in the rankings with an 18% slice of the 1986 $59 million market. "There are great expectations for the 80386," says Hambrecht & Quist's Herwick. "Multibus II is gaining momentum."

But bus structures and microprocessors are not inextricably linked. While Multibus II was designed with Intel's 80386 in mind, and VMEbus developed for Motorola's 68020, both buses can be used with other microprocessors. And 32-bit chips can be put on 16-bit buses. Steven Cooper, product marketing manager for Intel's original equipment manufacturer (OEM) module operations, estimates that about two-thirds of the 80386s that are being bought by vendors are designed onto Intel's Multibus I, 16-bit bus architecture.

Microprocessors, however, are not the only products Intel and Motorola sell. For both companies, bus architectures have a more concrete connection to the bottom line. At Intel and Motorola, board-level products have become a multimillion dollar business. Both companies initially began selling board-level products in order to sell more chips, says Hughes. "But when [the market] began to hit $100 million each company made a separate business unit," for board-level products, he says.

Intel's board business

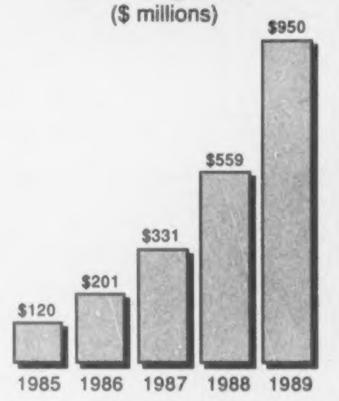
At Intel, for example, board-level products represented 8%, or $109 million, of the company's 1985 $1.36 billion revenue. And it is growing. Between the first and last quarters of 1986, says Robert Hanson, Intel's general manager of OEM modules operations, the board business grew exponentially, by a factor of five.

Board-level products are vital to Motorola, too. While the company will not break down its revenue by product, Motorola is the top vendor of VMEbus-based board-level products. According to Frost & Sullivan Inc., a market research firm in New York City, Motorola heads the list of VMEbus makers with 21.2%, or $44.5 million, of the $210 million market for VMEbus board products.

Another leading VMEbus products vendor contends that Motorola's board-level zeal has made life difficult in the VMEbus market. DY-4 Systems Inc., in Ontario, Canada, makes ruggedized VMEbus boards for military, telecommunications and industrial automation applications. Says Terry Black, DY-4's vice president of sales and marketing, "Motorola has been aggressively buying market share at the expense of profits."

VMEbus products expecting 66% compound annual growth

($ millions)



Source: Frost & Sullivan Inc.

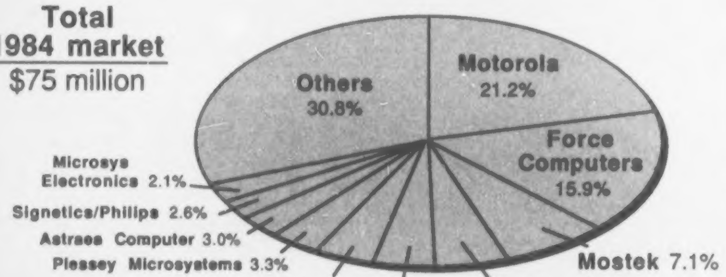
Jeffrey Gorin, Motorola's manager of product applications in the microcomputer division, disagrees. Three years ago, Motorola initially introduced midrange board-level products, explains Gorin. Since then, says Gorin, manufacturing costs have come down, component prices have dropped and Motorola has filled out its line of products with both low-end and high-end offerings. All that amounts to is a 6% to 25% drop in board-level prices, says Gorin, not price slashing.

But Motorola may soon have its hands full with Intel and other Multibus II manufacturers. Market figures for both VMEbus and Multibus II are difficult to come by and analysts rarely agree. All analysts concede, though, that VMEbus products now control the 32-bit bus market but that Multibus II will not be far behind for long. Hughes expects 50 or 60 more manufacturers to announce Multibus II board products this year.

Some expect Intel to parlay the proliferation of Multibus I products into sales for Multibus II. For one, Intel's Hanson anticipates that Multibus I board manufacturers will upgrade their product lines to 32-bit microprocessors and Multibus II. He also expects benefits from Multibus I's name recognition. But Hughes thinks that the popularity of Multibus I may not provide such ready acceptance of Multibus II. "Some Multibus I customers will upgrade but most of the prospects are coming from the mainframe arena," says Hughes. "Multibus II is getting a lot more sophisticated customers." ☐

Top 10 VMEbus suppliers control 70% of the 1984 market

Share of market by company



Source: Frost & Sullivan Inc.

Defense contractors defend a market

The heyday of ever-increasing defense dollars is over, but smart military contractors still find competitive opportunities

By John Kerr

Military contractors that think the worst of the defense-budget squeeze is over are wrong. Funding for defense is expected to shrink and will continue to put the clamps on programs big and small. Moreover, the contraction will persist until the end of the decade, to be followed by a miserly upturn in the mid-1990s.

"We can't see Congress allowing the Defense Department 4% growth when the economy is only going to be growing at 2% to 3% annually," explains Don Weaver, chairman of the ten-year forecast subcommittee for the Electronic Industries Association's (EIA) government division.

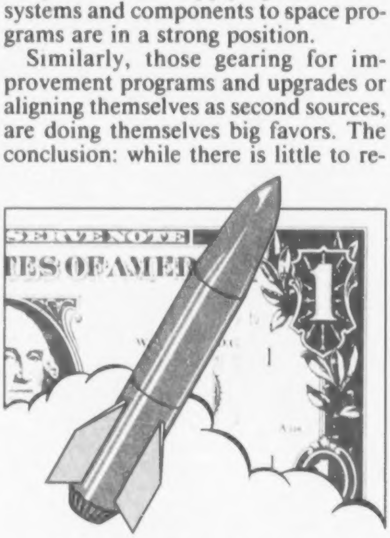
Weaver's group predicts that Congress will tighten the total defense budget tourniquet from fiscal 1987's budget authority of around $283 billion to $272 billion by 1990, easing off to let funding reach $284 billion by 1996, not including inflation.

But don't break out the collection box for defense-electronics contractors yet. While the EIA foresees a near-term drop in electronics content of the Department of Defense's (DoD) budget, from $53.5 billion in fiscal 1987 to $52.4 billion in 1989 in procurement; research, development, test and evaluation (RDT&E), and operations and maintenance (O&M) sector will jazz up the decade-long defense dormancy and reach $58 billion in 1996.

In part, this is because demand will continue throughout for computer, infrared, electro-optics, and laser technologies, intelligence-gathering equipment, electronic-warfare (EW) programmable jammers and millimeter-wave hardware.

But, it is also because some sectors seem immune to budget cuts. While contractors solely reliant on new missile and aircraft business will still feel the pinch, those supplying electronics systems and components to space programs are in a strong position.

Similarly, those gearing for improvement programs and upgrades or aligning themselves as second sources, are doing themselves big favors. The conclusion: while there is little to rejoice over in grandiose big-ticket strategic business, there is plenty of work in between, in humbler more conventional warfare programs.



While there is little to rejoice over in grandiose big-ticket strategic business, there is plenty of work in humbler more conventional programs

The EIA's overall $283 billion defense figure is middle of the road. Less gloomy is Hewlett-Packard Co. cofounder David Packard, chairman of the President's Commission on Defense Management, who forecasts 1.5% real growth in coming years. He says that Defense secretary "Caspar Weinberger is talking about 3% real growth; I don't think Congress will support that level of growth."

Others believe even the EIA's numbers are sugar coated. "Things are not going to get better — they're going to get worse. The 1988 budget could be down $25 billion in 1987," warns Robert Walters, deputy director for the national security committee on the budget at the House of Representatives.

Whichever prognosis, contractors feel ill already. Researchers tell them that new programs will be rare, and program stretch-outs, delays and recompetition will be the order of the day.

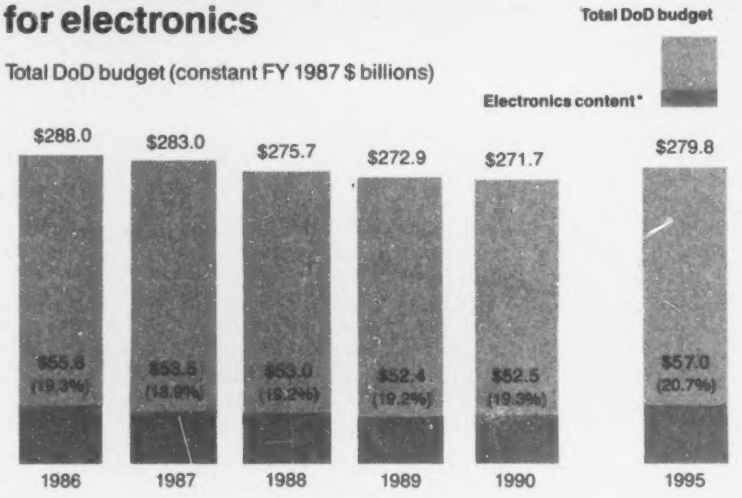
The big losers will be shipbuilders and missile and aircraft manufacturers, as procurement contracts mature without many to replace them. Congressional diktat says the 1980s hardware-buying binge — from 1982 to 1986 procurement outlays amounted to $344 billion, up 56% on the previous five years — just cannot be sustained.

The same goes for RDT&E programs: contractors can expect fewer new starts. Even President Reagan's darling, the Strategic Defense Initiative (SDI), or "Star Wars" program, will not see full-scale engineering development before 1996. "It won't be as easy as it was during the gravy days of the [anti-] Soviet build-up," cautions Weaver.

The military paradox

Paradoxically, defense contractors have more new business opportunities than ever, despite declining budgets. The prime reason is recompetition: one contractor's poison becomes another's meal as programs are spread

Defense spending: $54 billion for electronics



*Electronics content includes procurement, RDT&E and O&M

Source: Electronic Industries Association

out between two or among more suppliers. The winners are those that anticipate what is up for grabs: "The real problem is betting on the right horses," says James Lee, corporate manager for market analysis at Hughes Aircraft Co.

News of a downturn comes as no surprise to alert contractors. Cutbacks are the inevitable fallout from years of defense overspending, and must be seen in perspective: defense budgets, though deflating some, are still airy enough to float above the historic trendline dating from 1960, and will remain so because no politician these days wants to hamstring defense to the point where the country is imperiled.

Law makers, however, are happy to hound a military-industrial complex that they believe has not given the taxpayer the best deal. There is a strong political tail wind following the defense-reform proposals of the Packard Commission. And the mood is for streamlined acquisition procedures, better auditing and more use of commercial products.

The military is getting the message; it already appears that there is no such thing as a cozy sole-source contract anymore. According to the EIA, 50% of all prime U.S. contracts are now bid competitively versus 33% only two years ago.

Even the prime contractors are beginning to insist on jousting among their subcontractors. Just as the military services industry has appointed "competition advocates" to ensure that dual-sourcing is the order of the day, so major corporations such as Boeing Co., General Dynamics Corp. and General Electric Co. are setting up their own advocacy departments.

Defense contractors are also being encouraged to cut costs by shopping abroad for nondevelopmental items — systems already developed elsewhere — and by teaming with foreign firms to develop new hardware.

The military's use of commercially available off-the-shelf products draws mixed reviews. Many claim this practice is in full swing, a good example being the $2 billion worth of standard 32-bit desktop computers the Army wants for command and control duties. Others hold that it is impossible to sway long-held military-specification beliefs: "You could offer [the military] the war-winning weapon and they wouldn't buy it because it isn't MilSpec. I'd say good luck," retorts Wolfgang Demisch, an analyst with First Boston Corp. on Wall Street.

The new era of defense contracting is pushing some players toward the critical mass they feel that they need to compete. Wall Street pundits like Edmund Greenslet of Merrill Lynch, Pierce, Fenner & Smith have predicted industry consolidation for years, and 1986 looked like the year it began to roll.

Early in the year, General Electric bought out RCA Corp. in one of the biggest buys the electronics industry had ever seen. In mid-1986, Loral Corp. made a play for Sanders Associates Inc., but was outbid by the mighty Lockheed Corp. And in late fall, Emerson Electric Co. agreed to buy Hazeltine Corp. for about $189 million. Further buys are expected: Ford Motor Co., stung by losing Hughes to General Motors Corp. in 1985, is keen to compensate, possibly with an attractive defense-electronics bargain of its own. And Goodyear Corp., now restructuring, may be seeking other aerospace action.

> The mood is for streamlined acquisition procedures, better auditing and more use of commercial products

One alarming trend is the increase in dollar value of "black," or classified programs. First Boston's Demisch puts this "spreading blackness," as he calls it, as high as a third of all RDT&E work and possibly 20% of procurement.

It is an undercurrent that few are pleased with. Says Demisch: "Expansion of black programs reduces the public's understanding of the business and, consequently, is a significant negative across the board." Defense-electronics executives say that this is evidence of growing distrust between the Pentagon and the contractors, and they describe the trend as disturbing. Not only does it make communications more difficult, but it slows potential negotiations and adds inefficiency to the contracting process, which is good news for no one.

Good news is what contractors, dependent on major missile procurement programs, would prefer right now. The EIA predicts that procurement funding for this sector will fall from this year's $6.1 billion to $5.4 billion by 1996 as strategic programs like the land-based M-X intercontinental ballistic missile made by Martin Marietta Corp. and the submarine-launched Trident primed by Lockheed reach completion.

Program stretch-outs and delays will be the norm; the dramatic reductions in nuclear stockpiles discussed during the Reagan/Gorbachev talks in Iceland, although welcomed by most people, are less hearty news for the missile makers. One bright spot on the strategic front: Trident is a key candidate for being re-competed.

Steep drop-offs of big-ticket strategic missile production funds will tend to mask the slower slide in cash available for building tactical missiles like Hughes' Advanced Medium Range Air-to-Air Missile (AMRAAM) and the Stinger AAM.

Meanwhile, contractors on both

major procurement and development programs for the Navy can hardly avoid that sinking feeling. With the 600-ship fleet essentially completed or under contract, all that remains is equipment modernization and sporadic replacement of a few older vessels.

However, the Navy is throwing out life buoys galore — for those electronics suppliers diligent enough to spot them. Because of Soviet submarine advances, the United States is keen to enhance its antisubmarine warfare (ASW) capability. "We suggest you stay close to this one," EIA panel members told listeners at a recent defense-electronics symposium.

Navy cheerleaders for R&D on ASW were looking for $2 billion this year — twice that allocated in 1981. Advanced sonar for submarine surveillance will provide plenty of good opportunities in areas like sensor technology, multisensor fusion, fiber optics and artificial intelligence.

Additionally, mine warfare could present R&D openings. And the Navy may adopt a Local Area Anti-Air Warfare System (LAAAWS) to protect U.S. and NATO ships in a fiscal-1988 program start that could form the kernel of a "Naval Defense Initiative."

When it comes to aircraft, both procurement and development programs are up in the air. While late-1980s peaking and subsequent fall of spending on key elements like Rockwell International Corp.'s B-1 bomber distort budget figures downwards, activity in other areas keeps electronics subcontractors guessing.

The LHX, a proposed light attack helicopter, is something of a sacred cow with its sponsor, the Army. Should it receive approval, electronics suppliers can get out the champagne: two-thirds of the helicopter's value is in electronics.

On the fighter front, the Air Force propels its Advanced Tactical Fighter one stage forward by choosing Northrop Corp. and Lockheed as the two design finalists. Design is one thing, and production another, however; the Congressional jury is still out on whether it should upgrade existing aircraft, such as the F-16 with standoff weapons.

Generic defense

Guessing games aside, there are generic advances that will benefit electronics vendors. Be it for strategic or tactical theaters, the Air Force wants parts and systems with lower weight, lower power consumption, less heat dissipation and higher speed — the amalgam of "impossibles" normally twined with demand for lower cost. Electronics contractors offering systems that incorporate very high speed integrated circuits and self-testing features will be smiled upon.

Additionally, in B-1 and B-52 bomber upgrades, the Air Force wants to decrease operational costs by installing equipment with mean times between failures as high as 3,000 hours — up to 14 times today's norm.

Operation fightback: Countering terrorism with technology

There is a new war going on these days. With nuclear showdown on hold and conventional warfare in check, terrorism is the misanthropic militancy of the late 20th century.

So far, this "New War" has not cursed the United States. But studies suggest that this is an uneasy tranquillity at best, and that extremist violence is escalating. The Rand Corp., a think-tank in Santa Monica, Calif., says that the number of incidents worldwide has been rising 12% to 15% yearly.

This calls for retaliatory tactics which traditional peacekeeping forces have not yet mastered. It also challenges electronics vendors to devise equipment that helps combat terrorism.

Technology has already been critical to some celebrated successes against extremists. When Britain's Special Air Service (SAS) team stormed the Iranian Embassy in London in 1980, they put electronic eavesdropping equipment down chimneys and against walls to pinpoint the location of the gunmen. In 1977, Dutch Marines relied on advanced heat sensors and night-vision goggles to locate terrorists holding hostages aboard a train.

America's special-operations forces (SOFs) — including the Army's Green Berets, the Navy Seals and the Pentagon's supersecret Delta Force — have not shared comparable triumphs. Concern that America is far from ready for the New War is prompting legislation that may reorganize the way these counterinsurgency units are run.

The U.S. Senate's proposal — reckoned to have the best chance of becoming law — envisages a unified command structure reporting to the DoD. "Our goal will be for [special force] funding to be increased substantially," says an aide to Senator William Cohen, (R-Maine), the initiator of the Senate's plan.

That, says the EIA, makes special operations a sector worth watching. The trade group reports that SOFs budgets totaled $1.2 billion in fiscal 1986 and should reach $1.7 billion this year.

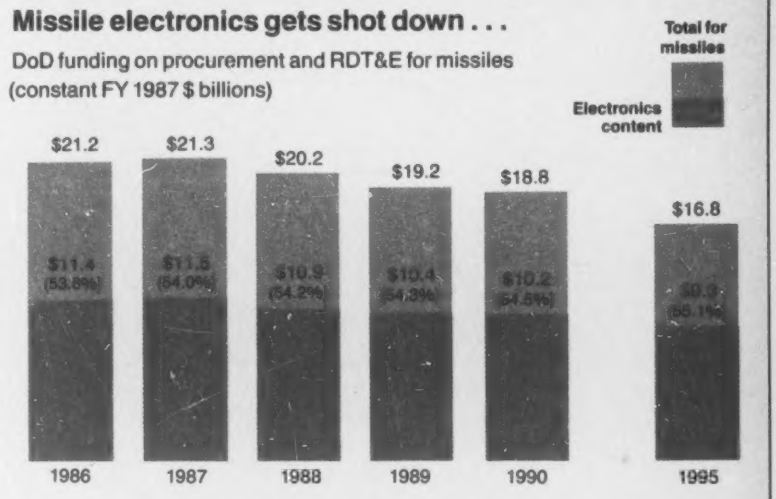
Proponents of higher funding maintain that SOFs is 0.005% of the defense budget, hardly commensurate with the seriousness of terrorism today. The EIA adds that much of the $1.7 billion will go to airlift planes and almost nothing to RDT&E, and the association predicts that over the next five years SOFs will get $7.5 billion.

Assuming an electronics content below the typical 20%, it could still yield $1 billion in business for electronics vendors, supplying equipment like: standardized avionics; three-dimensional night-vision goggles; global-positioning satellite receivers; command posts; and secure communications equipment.

Other technologies may be of benefit too: smaller closed-circuit TV cameras that work in the dark; optical disk systems to call up databases on known radicals; ballistic computers to give snipers unerring aim; sensors smart enough to tell a stray dog from an armed intruder.

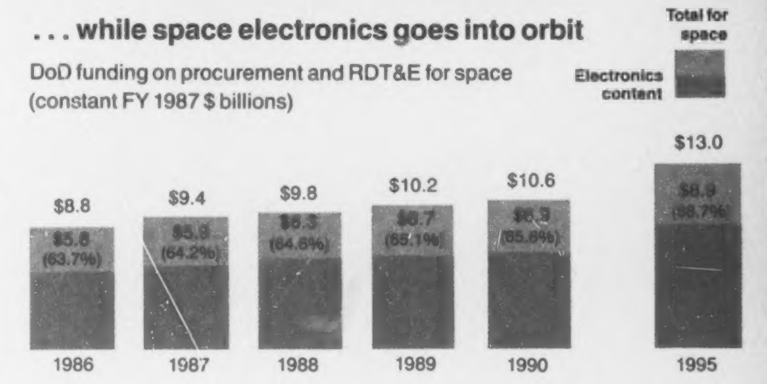
Many remain skeptical that extra SOFs funding will materialize during tight budget constraints and while terrorism is not perceived as a national threat. One equipment maker cites the difficulty another U.S. force, the Coast Guard, has in getting funds to counter drug smuggling. Another makes a telling aside: "Nobody ever got above brigadier with Special Forces."

Moreover, technology alone cannot permanently roll back the New War. "Unfortunately, there's no magic button you can press to stop all terrorists," says one vendor. ☐



Missile electronics gets shot down . . .

DoD funding on procurement and RDT&E for missiles (constant FY 1987 $ billions)



. . . while space electronics goes into orbit

DoD funding on procurement and RDT&E for space (constant FY 1987 $ billions)

Source: Electronic Industries Association

Suppliers matching those levels are ahead of the game.

Many vendors will be betting on mainstream electronics growth areas like integrated battle management and command, control and communications (C^3). C^3 funding of over $24 billion was requested for fiscal 1987, double the 1982 amount. Among the more interesting — though volatile — program possibilities are the Midgetman small intercontinental ballistic missile C^3 package and the Worldwide Airborne Command Post, both for the Air Force.

And there is often-overlooked business in computer security and management information systems for the Pentagon and related agencies: up to $16 billion worth, according to the EIA.

Space dollars

But the sector that remains robust like nothing else is space electronics. Thanks largely to growth in procurement of communications and reconnaissance satellites, military acquisition of expendable launch vehicles and the Military Strategic Tactical and Relay (MILSTAR) satellite, procurement funding here will soar from $2.6 billion this year to $4.8 billion in 1996. Similarly, RDT&E space-electronics monies will expand from $3.3 billion to $4.5 billion in the same period, fueled by ongoing research on C^3 and by SDI concept work.

Interestingly, SDI has lost some of its shine in the past year. Although there is now a vocal lobby campaigning to implement a diluted version soon, rather than waiting forever for its completion, opponents of the mega-research program have had considerable say of late.

Fiscal 1987 funds for Star Wars came in just over $3.5 billion, up 17% from last year, but about 30% less than the President's request. Consensus is that SDI is here to stay; with 1,000-plus contracts awarded so far, it has acquired a momentum all its own. "We don't see it being terminated — even under a democratic administration," remarks Nathan Higginbotham, manager of government programs at McDonnell Douglas Corp.

The program is being reshaped, however. Directed-energy weapons — the "ray gun" systems that SDI is notorious for — may lose backing in favor of areas like battle management and C^3. And SDI itself may lose out to more popular alternatives.

Indeed, law makers on Capitol Hill have gotten more excited about two other defense initiatives: ADI and especially CDI. ADI — Air Defense Initiative — is intended to guard against the threat to U.S. airspace from Soviet bombers just as SDI is meant to protect it from Russian missiles. The program is considered a very high risk, but could quickly amass backing for proposed R&D funding of $606 million from 1987 to 1991.

But the Conventional Defense Initiative (CDI) is what has Congress jumping. "It swept [Capitol] Hill like wildfire," says Hughes' James Lee. CDI began as a proposal by the House Armed Services Committee (HASC) that sought to redress the R&D balance and move it away from strategic warfare and toward tactical warfare.

The $462 million proposed for fiscal 1987 by HASC — the authorized total came in well under that — is coming out of SDI's hide and would fund an array of tactical defenses intended to have as much visibility as SDI, but for a fraction of the cost. Technologies would include: smart air-launched standoff munitions; smart mines — both land and ocean; and hypervelocity missiles for ground combat.

Meanwhile, there are hosts of advanced-technology programs for defense-electronics companies to address. Today the talk is of "brilliant" weapons, systems whose intelligence merits more than the term "smart." Opportunities will likely open up in infrared focal-plane array producibility; microwave/millimeter wave monolithic integrated circuits; optical switching; and "vetronics" — vehicle electronics, that would lead to robot tanks and other unmanned vehicles.

In one critical area — manufacturing productivity — attention is wandering. Despite the promise of gains in both quality and production cost on all sorts of defense systems, manufacturing technology programs appear to be on the backburner. One theory is that no military top brass earned medals rooting for projects viewed more as penny-pinching pedantry than political pennants. "It's like the kiss of death," says one electronics contractor. ☐

Marching to the beat of foreign drummers

America once called the shots in military electronics deals overseas. But now, here comes Europe and Japan

By John Kerr

Gone are the days when U.S. defense electronics contractors rode carefree atop America's mighty military juggernaut. Today they risk being pushed off by aggressive overseas contestants.

They risk rebuff abroad too. In Western Europe, many American defense firms are experiencing cuts in sales. In the Third World, they are steadily losing to European protagonists.

American incompetence is not the cause. Put it down instead to "internationalization" of the arms trade. "Everybody is demanding a piece of the action these days," says Bernard Schwartz, chairman of New York City-based electronic-warfare (EW) specialist Loral Corp.

The action is accelerating as military-equipment sales crisscross the globe in an ever more intricate web, and as contractors from many nations team up to tackle today's complex weapons programs. The industry's new globalism is apparent in efforts by Japanese vendors to capture a larger portion of the military electronics market. It surfaces in the Pentagon's desire for Japanese technology. It appears in new participation of nations not renowned for their military-equipment might, like Canada and Brazil. And it is evident as European firms jointly bid with U.S. partners on prestigious programs on both sides of the Atlantic.

In Europe especially, America is seeing a dwindling dominance in defense equipment. Many there have long complained that arms trade has been a one-way street — in America's favor. Independent analysis bears them out: the trade journal *Military Logistics Forum* reports that the 1970s saw the United States exporting roughly nine times the value of defense equipment to other North Atlantic Treaty Organization (NATO) countries as it imported. And the trans-Atlantic trade picture is changing fast. By 1985, claims *Military Logistics Forum*, the export/import ratio had dropped to three to one. The U.S. Arms Control and Disarmament Agency confirms that U.S. arms exports are falling after a long period of growth: from $11.8 billion in 1983 to $9.4 billion last year.

Today's multinational military market is as much the product of improving capability among foreign contractors as it is of encouragement by the Congress of competition in procurement, which opens U.S. military programs to overseas suppliers. And political expediency plays a plumlike role. With Congress pushing the armed forces to buy more "nondevelopmental items" — systems already developed elsewhere — Britain is hoping it can sell its Rapier mobile antiaircraft missile system to the U.S. Army as a replacement for the failed Sgt. York Divisional Air Defense (DIVAD) weapon. There are also European hopes of supplying trainer aircraft to U.S. forces.

America is seeing a dwindling dominance in defense equipment

European expertise, eroded by the ravages of World War II, has bounced back with a vengeance. "Ten to 20 years ago, the U.S. was clearly the leader in defense technology in the Free World. The European defense industry since then has caught up and in some instances is ahead on delivery schedules, pricing and technology," says James Lenehan, Rockwell International Corp.'s director of foreign trade policy.

Predictions are that this capability will only improve. With designs for several new all-European-made fighter jets already in the planning stage, Europe may be building up to 4,000 of its own fighters by the mid-1990s. National-defense markets in countries like West Germany and Italy are much too small to warrant homegrown arms supply. But under the umbrella of the European Economic Community (EEC) — the "united states of Europe" — coproduction ventures like the Tornado warplane become viable. "They're going to have an economy of scale that will make them very, very powerful," adds Lenehan.

Europe's new-found domestic strengths, backed by an overt Euro-chauvinism, make it harder for U.S. firms to export there. "It's difficult to sell directly into countries that have capabilities of their own," says John Dixon, chief executive of E-Systems Inc., a Dallas electronic warfare company.

Like others, E-Systems has seen its overseas sales dented. Palo Alto, California-based Watkins-Johnson Co., whose defense products include test equipment, experienced a downward step in 1985 exports to $42.9 million — 18% of total sales — from $46.3 million, or 22% of total revenue, in 1984. Even Loral, which has boosted the dollar value of its exports to a quarter of its backlog, concedes that it is no picnic: "There's no question that the sales are harder than they were," says chairman Schwartz.

But, some Euro-observers feel that

European firms are hardly on easy street when in comes to selling into the States. "The two-way street has turned out not to operate. It's extremely difficult for British companies to sell into the United States," remarks Miles Saltiel, a financial analyst with Prudential-Bache Securities Inc. in London.

The American dream

British electronics giants The Plessey Company Plc. and Racal Electronics Plc. are trying to prove him wrong. "The American market *has* to be my No. 1 market," says Michael Whiteman, managing director of division Plessey Avionics, which is teamed with Boeing Aerospace Co. to compete for a replacement for Britain's Nimrod airborne early-warning (AEW) system. Whiteman's $75 million operation has grown sales to the United States from $5 million at its inception three years ago to $10 million now, and it is stepping up the pace with new consultancy agreements in Washington D.C., and on the West Coast.

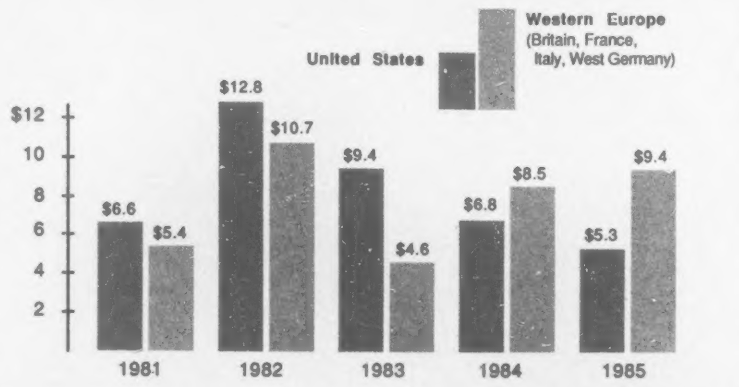
Others, like Racal, are acquiring American accents. Racal-Dana Instruments Inc. was formed in 1977 when Racal took over Dana Laboratories in California and today builds about 80% of what it supplies to U.S. forces there. Explains Brian Hull, vice president of marketing: "We feel it's important not only to have a domestic presence but to have [local] engineering content."

LORAL's SCHWARTZ: "There's no question that sales [of military exports] are harder than they were"

Hull's company has just beaten Hewlett-Packard Co. and others to clinch a $10 million-plus order from Kelly Air Force Base for universal counters, and expects to double 1986 bookings to $20 million. Racal is not the only European supplier to set up shop here: the Marconi group of Britain's General Electric Company Plc. (no relation to GE in the States) has a factory in Atlanta producing "head-up displays" for jet fighter pilots and another U.S. plant building automated test equipment for the military.

The U.S. is losing Third World arms business to Western Europe

Arms transfer agreements with the Third World by major supplier (current $ billions)



Source: Congressional Research Service

But many believe it will be tough to ignore mounting nationalism in the States and even harder to beat an entrenched "buy-here" mentality that despite Congressional urging to source already-developed equipment from abroad, means the two-way street still has a noticeably unidirectional flow. "There still is a very strict bias with government to buy American," says Philip Friedman, an analyst with Wall Street investment brokers Drexel Burnham Lambert Inc.

To counter growing nationalism on both sides, the answer for American and foreign companies alike lies in collaboration, or "teaming." "Arms cooperation is the name of the game — finally," says Dr. Charles M. Perry, a senior analyst with the Institute for Foreign Policy Analysis Inc., a Cambridge, Mass., think tank. Foreign players get guidance from U.S. partners in circumnavigating the bureaucratic maze, and vice versa. Pockets of expertise across the globe can link up to tackle defense programs with worldwide application. And all of them can share the costs — and risks — as weapons programs grow in complexity.

Teamwork

Teaming is nothing new, and examples are myriad: McDonnell Douglas Corp. builds the Marine Corps' AV-8B version of British Aerospace Plc.'s Harrier "jump-jet." Racal and GE's RCA Corp. have long shared radiocommunications work. And recently, France's Thomson SA and America's GTE Corp. jointly won the $4.3 billion Mobile Subscriber Equipment (MSE) contract for battlefield cellular telephones from the U.S. Army.

Elsewhere, teaming is also teeming. Rockwell is hand-in-glove with Marconi on the Navy's High-Frequency Anti-Jam (HFAJ) communications program. GE and Germany's Siemens AG are jointly developing a new artillery surveillance radar system for the West German army. The U.S., Great Britain and West Germany have signed a memorandum of understanding for coproduction of Hughes Aircraft Co.'s Advanced Medium-Range Air-to-Air Missile (AMRAAM) and Europe's own ASRAAM short-range missile. And an international consortium developed the Multiple-Launch Rocket System (MLRS).

The Pentagon prompted RSI — rationalization, standardization and interoperability — in the early 1980s, but with little effect. Later, a NATO Armaments Cooperation steering group was formed at the Department of Defense. But it took horror tales of $600 toilet seats to put fire under those responsible for defense procurement.

Now Congress is pushing the process into research and development (R&D) too. An amendment to the fiscal 1986 defense bill by Senator Samuel Nunn (D-Ga.) allocates $250 million to spark cooperative R&D projects with European companies. Already some have kicked off: there is joint work on a NATO "identify friend or foe" system; a modular stand-off weapon; a precision guided munitions project; a software support program, and several others. However, many contractors are still waiting to see how well teaming really works. Two significant bellwethers are the GTE/Thomson MSE program, and the Boeing/Plessey AEW bid, if it wins.

Heavens above

Meanwhile, President Reagan hopes his Strategic Defense Initiative (SDI), or "Star Wars" program, becomes the very model of global cooperation. Argument rages over how much the Allies should participate: all in favor say aye, largely because it is politically expedient to include nations that might otherwise harp about the drawbacks of the multibillion dollar program. The nay-sayers point out the folly of handing foreigners the technology — with the cash to exploit it. Gripes one critic: "It's a free lunch. They get the U.S. taxpayer to pay for advanced research."

Europe insists that an all-American SDI would corrode the spirit of NATO and put giant potholes down one side of any two-way arms-sales street. So far, though, 'ayes" outweigh "nays": during fiscal 1987 budget battles, Congress voted down an amendment by Senator John Glenn (D-Ohio) which would have limited participation by the Allies.

Not a lot has gone overseas yet: for fiscal 1986, the SDI Office says that under $20 million of the $2.7 billion allocated to "Star Wars" — less than 1% — went to foreign research. Recipients included Britain's Ferranti Plc. and Heriot-Watt University, which between them obtained $285,000 for optical-computing studies.

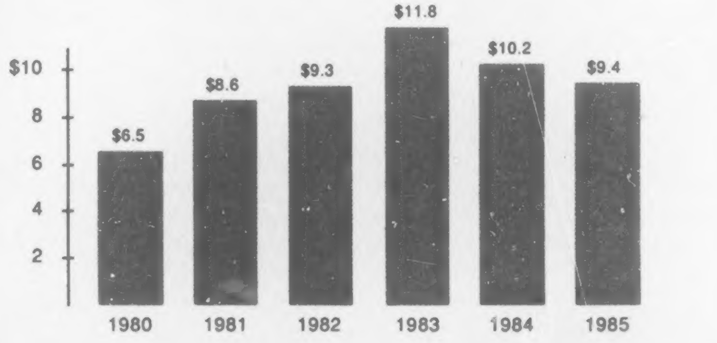
During fiscal 1987, when $3.2 billion has been authorized for SDI, some larger overseas contracts will start rolling: Israeli organizations alone have been granted some $5 million for multiyear computer architecture studies. However, it will be a year or two before the overseas portion expands much in percentage terms.

Enter Japan

SDI is providing the invitation that could admit one especially coy nation to the global defense-technology club: Japan. In mid-1986, Prime Minister Yasuhiro Nakasone inked a declaration of intent to consult with the United States on SDI. The U.S. hope is that Japan will formally sign up soon and thus begin contributing in essential research areas like gallium-arsenide semiconductors and electro-optics.

America's defense exports: Sounding the retreat

Value of U.S. military exports (current $ billions)



Source: U.S. Arms Control & Disarmament Agency

Traditionally, Japan's defense budget has been minimal and its population, with World War II deep in the national subconscious, reluctant to build a showy arsenal of its own, much less sell arms abroad. Political encouragement — notably from Washington — is urging that Nakasone's government get out from under America's defense umbrella. The unspoken message is: put some of the funding you so willingly use for technological one-upmanship into military self-reliance.

Few U.S. defense contractors feel it is worthwhile trying to market in Japan; fewer believe that will change. America's frustration with Japan's trading tactics surfaces readily. Argues Christopher Demisch, a Wall Street analyst with First Boston Corp.: "The Japanese distinguish themselves by buying as little military hardware as possible. They have a $50 billion annual trade deficit, and they don't buy. And we're stupid enough to sell [the technology] to them."

Instead, Japan builds for its tiny armed services under license: McDonnell Douglas' F-15 is made there; so are Loral's ALR-56 radar warning receiver for the F-15, and Lear Siegler's automatic flight control system for the P-3C aircraft.

U.S. officials cringe at what seem to be deplorable economies of scale. Says Rockwell's foreign-trade policy chief Lenehan: "When you transfer technology, you can't build these things anywhere near as efficiently as the guy making them in four figures. They would get more clout for their yen if they bought from the U.S., plus they'd reduce their terrible trade balance. I think they're insisting on it so they can learn the technology so that 10 years from now they can be a producer."

If that is so, it may be a case of who gets what out of whom first. The Pentagon covets Japanese technology, and under a 1983 Washington-Tokyo agreement, has helped set up a joint military-technology commission to facilitate technology transfer, mostly to the States. The agreement provides a framework for both governments to encourage private industry to initiate technology exchanges. So far, though, results have been poor.

The developing world

Beyond NATO, Japan, Australasia and the Warsaw Pact nations, that leaves only the Third World as a market. And there, if some observers are to be believed, U.S. contractors are on

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Sending CAD tapes to photoshops an unnecessary step, PCB maker claims

To move CAD designs more quickly into production, and produce higher-quality fine-line double-sided and multilayer SMOBC boards, Velie Circuits' state-of-the-art equipment adapts to customer mag tapes

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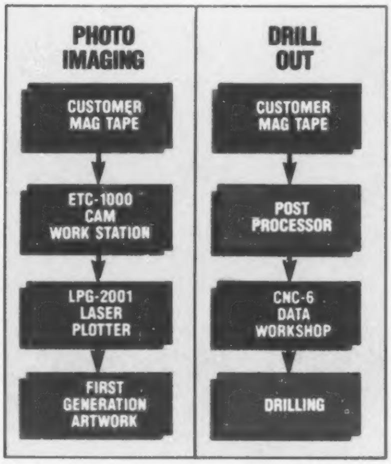
The result: cleaner images, minimal handling of artwork and improved film stability—without using outside photo-houses.



Steps to generate artwork and drill-out directly from customer mag tapes.

Data for drill-out, on the other hand, is directed through a post processor into a CNC-6 Data Workshop which establishes formats and sets drill functions for optimum hole location accuracy.

Quality is further enhanced by a new Orbot PC-1031 to check line widths and spacing to less than one mil resolution. Thus, the quality of impedance control boards is ensured by controlling line widths over the full length of the trace.

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JAPANESE PRIME MINISTER NAKASONE has put his signature on an agreement declaring his country's intent to consult with the U.S. on Star Wars

Reuters/Bettmann Newsphotos

business. The Third World doesn't have any money. They want an arm and a leg, and they want you to pay them for buying it *and* set up an industry for them to boot. This is a business where the profitability is very low in the long term," maintains First Boston's Demisch.

Indeed, arms deals with the Third World are on the decline, and the U.S. share along with it, according to the Congressional Research Service at the Library of Congress. The value of U.S. arms transfer agreements dropped to $5.3 billion in 1985 from $9.4 billion in 1983, in current-year dollars.

One reason for the drop-off: those pesky Europeans going international again. Britain, France, Italy and West Germany traditionally have had strong arms exports to developing nations. Great Britain boosted its share of all Third World arms agreements to 21.8% in 1985, from 1.6% the year before, largely because of a multibillion dollar aircraft contract with Saudi Arabia. The trendline of major European nations' Third World arms contracts is steadily up; the U.S.'s is spiraling downward.

Partly it *is* because less-developed nations have limited money; partly it is because security-assistance funds from the States have been plunging. But, it is also the product of growing arms-production capability in nations like Brazil and Israel — and of stiffer insistence by many countries on tough offset agreements, whereby the purchasing nation demands participation in production or by trade reciprocity, if it has goods to offer in return. A good example is the oil which British Aerospace once had to take for sales of the Tornado fighter it helps build.

According to Patrick M. Hall, vice president in charge of Rockwell's internal trading house for dealing with offsets and counter-trade, offset contracts are on the rise. "Five years ago, there was hardly any to speak of," he says. Hall has felt the brunt of new offset-negotiating skills in Korea and Greece. As often as not, emerging nations like these have learned the offset game from tough First-World experts like Australia and Canada.

Before buying United Technologies Inc.'s Sikorsky helicopters for its navy, Australia demanded to build the machine and to write much of the computer software for the craft. Holland is another nifty negotiator: The trading-house run by Rockwell's Patrick Hall buys Dutch-made electronics parts for several Rockwell groups as part-payment for submarine communications gear for the Dutch navy.

And on Raytheon Co.'s Patriot air-defense missile, Holland demands nearly 100% offset with "in-program" deals that see parts of the system built in Holland, and "out-program" pacts, where America's Defense Department sources Dutch electronics equipment for various applications.

Britain too is showing Falklands grit in negotiations with Boeing on the Nimrod airborne early-warning system, which originally called for 100% offset. But the Westminster government, plagued by unemployment issues, forced Boeing's arm up to 130% offset, meaning that Boeing will give more than it gets. The agreement now calls for British firms to get AEW work that employs up to 8,000 a year, plus future contributions through Boeing to U.S. programs in everything from fiber optics to data links.

Crisscross trading arrangements like these give U.S. contractors logistics headaches. "It's a continuous problem for them to find offsets. People feel they're getting the short end of the stick, and they'd rather be doing something else," argues Demisch.

But when Asian Pacific defense markets like Korea are hot and U.S. markets are not, and when big programs like the British AEW come along, there's often not much else to do. Offsets, admit hard-pressed U.S. defense contractors, are simply the price of staying in what is very much an international game these days. ☐

Silicon Glen tunes in on just-in-time

The Scottish Development Agency is using JIT delivery to lure manufacturers and improve their supplier pipeline

By Bruce C.P. Rayner

The Scottish Development Agency (SDA), which has a major directive to attract foreign investment, is counting on a vast just-in-time delivery project to provide a competitive advantage. An additional advantage is required as the worldwide electronics slump has curtailed industry expansion at the same time more nationally and regionally sponsored agencies are offering equal packages of market proximity, skilled workforces and tax advantages.

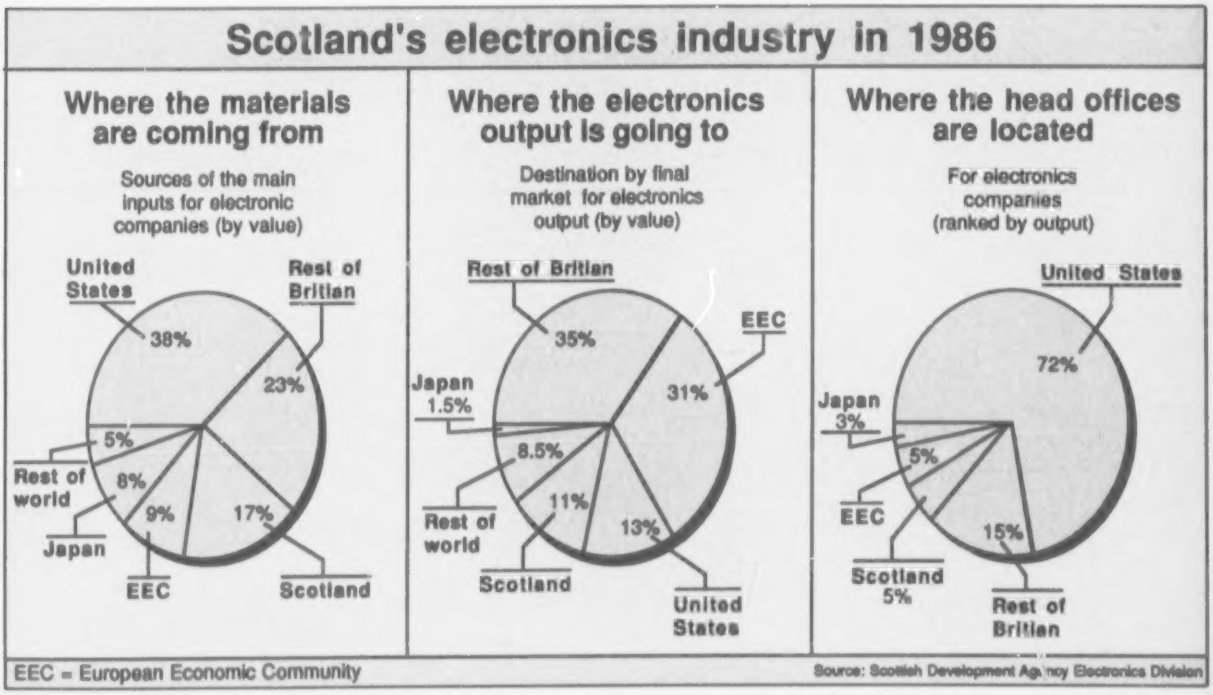
Many of the world-class electronics players are located in Scotland's central belt dubbed Silicon Glen — Burroughs, DEC, Ferranti, Hewlett-Packard, Honeywell, IBM, Motorola, NCR, NEC and Wang to name a few — and the SDA is always trying to attract more. The SDA officials hope to use Japan's just-in-time manufacturing system's (JIT) philosophy and tailored it to suit Scotland. JIT has two components: intrafirm JIT, to improve productivity and efficiency *within* the firm; and interfirm JIT, or JIT sourcing, to strenghten relationships *between* a manufacturer and supplier. SDA officials hope that if Silicon Glen embraces JIT, the area will continue to attract foreign investment.

By accident or design, Silicon Glen represents an almost unique agglomeration of electronics firms. It has the highest concentration of electronics companies in all of Europe and is similar in some respects, but on a smaller scale, to both the high-tech highway of Route 128 around Boston and the Silicon Valley region south of San Francisco.

Industry concentration provides certain economies, but there are additional advantages that can be reaped through corporate cooperation. If the high-tech community can be encouraged to cooperate to smooth production — both upstream with customers and downstream with suppliers — substantial savings can be derived from the close proximity, and sales can go to Scottish suppliers rather than foreign sources.

The savings attributed to JIT come from coordination of production runs, closer communication, tighter delivery windows and lower transportation costs. Quite simply, just-in-time sourcing — delivering the right quantity and quality of product just where and when your customer needs it — is essential to Scotland's continued success in the European electronics marketplace.

The pressure to smooth supply



Scotland's electronics industry in 1986

Where the materials are coming from

Sources of the main inputs for electronic companies (by value)

Where the electronics output is going to

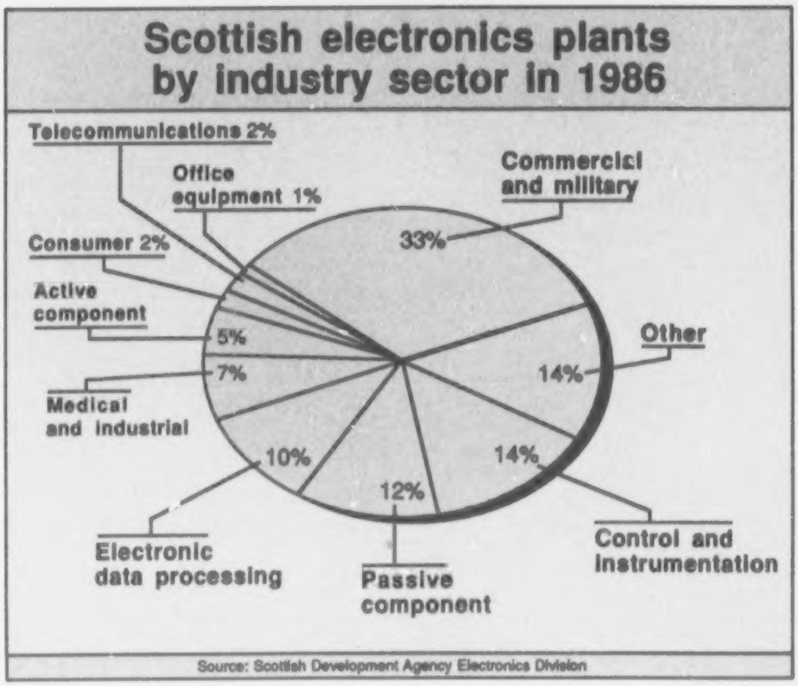
Destination by final market for electronics output (by value)

Where the head offices are located

For electronics companies (ranked by output)

EEC = European Economic Community

Source: Scottish Development Agency Electronics Division



Scottish electronics plants by industry sector in 1986

Source: Scottish Development Agency Electronics Division

channels is coming mainly from the onshore Japanese and American electronics manufacturers that have already adopted JIT internally. Many of them flatly refuse to source locally if the supplier does not adopt JIT. As the SDA reports, only about 12% of the industry's incoming supplies are sourced in Scotland, although most of the supplies are locally available. Seventy percent of U.S. and Japanese companies located in Scotland purchase 25% or more of their materials and components from their home countries.

At the same time, Pittiglio, Rabin, Todd and McGrath (PRTM), the international high-tech consulting firm that works with the SDA, claims that over the past four years, many manufacturers have reduced their supplier base by up to 80%, contributing further to the reduction of Scottish sourcing. One international company located in Scotland has reduced its suppliers from 1,000 down to 200 while another has dropped from 450 to 280, PRTM claims.

In cooperation with electronics manufacturers, the SDA hopes to reverse this trend by championing the JIT sourcing cause. Jeffrey Berg, one of three PRTM consultants headquartered in East Kilbride, Scotland, says that through implementation of JIT, the Scots have the potential to catch up with the United States in three years and overtake the market within five years.

One reason for Scotland's potential is that the pieces are all in place. Scotland has a well-established electronics manufacturing base as well as a large pool of local suppliers — a characteristic shared by the U.S. market. But Scotland has two other qualities that are not duplicated Statesside. Suppliers, original equipment manufacturers (OEMs) and the end market are geographically close, and, perhaps more important, the existence of the SDA as an electronics advocate and facilitator. "No other country in the world, outside Japan, has this set of circumstances," Berg adds.

The role of the SDA

The SDA received its charter in 1975 through an act of Parliment. Its formal objectives are to further the economic development of Scotland and to promote industrial efficiency and international competitiveness. These goals are accomplished through financial assistance to develop new technology and to assist small businesses. The SDA is also a major industrial property owner and local area developer. In 1985, the SDA held 20 million square feet of floor space in over 220 locations.

The SDA, in cooperation with PRTM and international OEMs, is providing JIT educational seminars for suppliers as the main thrust to get the JIT ball rolling. But according to Dominic McKay, senior project executive of the electronics division of the SDA, there are other avenues the SDA is starting to pursue to promote JIT. The only problem McKay sees is that JIT sourcing is not catching on as quickly as he expected. As the cornerstone to Silicon Glen's growth, he says that there is still "room for improvement" in convincing vendors to adopt JIT sourcing.

> JIT sourcing is a long-term partnership between a manufacturer and a supplier

To get things moving a bit faster, McKay says, the SDA is: sponsoring a JIT Club for OEMs and vendors to get together and discuss problems and experiences with JIT; offering financial packages through the Industry Department for Scotland (IDS) — the industrial arm of the Scottish Office — actively seeking senior-level executive support for JIT sourcing; and running seminars for government agencies such as the IDS, the Highlands and Islands Development Board, the East Kilbride Development Corp., the Cumbernauld Development Corp. and the Livingston Development Corp.

Peter Carmichael, director of both the small-business and electronics divisions of the SDA, although enthusiastic about JIT, is concerned that there may be some disillusionment over JIT. That is, some will try it, find the results are not immediately forthcoming, and so abandon their plans and go back to the old ways. If this happens then JIT sourcing will never have a chance to get off the ground.

Another complaint is that the OEMs will bully the small suppliers by using JIT sourcing as an excuse for more sinister motives. "My only fear," Carmichael says, "is that if it is not done in a concerted way, [JIT sourcing will] just transfer inventory from the OEMs to suppliers."

The word from the OEMs

Most OEMs, however, would be quick to respond that JIT is anything but "the flavor of the month." Instead, most are looking to invest in long-term relations with suppliers. By definition, JIT sourcing is a long-term partnership between a manufacturer and a supplier, not coercive strategy for short-term gain. It is founded on trust that a quality product will be delivered on time when needed and involves sharing information and forecasts between the vendor and the manufacturer. This might result in a more expensive input initially, but the bottom line is that the total cost will invariably be lower. It is the reduction in total cost that will give the OEMs a clear advantage in the international marketplace.

Honeywell Control Systems Ltd., a division of Honeywell Inc., located in Motherwell, Scotland, found that in 1984 and 1985 the vendors with the best track record were those from offshore. Specifically, 90% of the materials received by Honeywell from local vendors were unacceptable, leadtimes to vendors were 12 weeks, promised shipping dates were often not met and price increases demanded by the vendors averaged double the running rate of inflation. As a result, Honeywell decided to pare down its vendor base and introduce a new purchasing strategy called the assured supply program (ASP).

Through ASP, Honeywell invited some key vendors, both local and international, to participate in a long-term "partnership" in return for the vendors' commitment to provide Honeywell with "maximum service and support in all business conducted," says Honeywell. Some of Honeywell's objectives include just-in-time sourcing, achieving zero defects in inputs and outputs, reducing leadtimes, shortening product cycle times and set-up times as well as improving communication.

By August last year, 12 vendors had formally entered into an ASP agreement with Honeywell and another 12 had been invited. Already acceptance rates with partnership vendors had risen to 98%, on-time delivery was up to 100% and vendor's leadtimes had come down to two to four weeks. Honeywell estimated that 100 partnership vendors would be sufficient to supply 80% of its needed materials.

With JIT sourcing, the total cost will invariably be lower

Another example of pressure from an OEM is Hewlett-Packard Co.'s Queensferry, Scotland, microwave and communications plant. HP started this operation in 1984 with JIT as an integral feature and is currently supplying the European market with about $1 billion in sales a year. The division estimates that about 60% of the finished-good cost comes from materials, with about 40% of that coming from subassemblies and 14% of that is from sheet metal for cabinets.

HP, traditionally a batch producer, is attempting to shift to a JIT philosophy both internally and in cooperation with its local suppliers. As subassemblies are such a high-value input and sheet metal is so bulky, HP's strategy has been to focus on reducing its inventory of these two components. One JIT supplier of sheet metal, Fife Fabrications of Glenrothes of Scotland, is cooperating with HP on improving forecast visibility, implementing ship-to-stock, reducing cost and improving delivery.

By shifting from multiple sourcing to single sourcing, Hewlett-Packard is getting its suppliers to only produce what is needed when it is needed and to try to make JIT as attractive to them as possible. So far, the company has been able to reduce its inventory from four months to less than two months, its build cycle of eight to 12 weeks to less than two weeks, and its customer leadtime from 12 weeks to less than four weeks.

Motorola Inc.'s Semiconductor Products Sector in East Kilbride, is also aggressively pursuing JIT sourcing. So far, the chip maker has reduced its total vendor list by around 90% and its active vendor list by around 50%. It has also managed to cut its own inventories by two-thirds. The East Kilbride facility is moving toward single sourcing its wafers and wants to do the same with its quartz and chemical suppliers. Chemical sourcing is now 100% local.

Motorola's objective is to turn its inventory over a minimum of 10 times a year, reduce its cycle time to 30 days — or 2 times theoretical standard — and ultimately get all of its suppliers to use JIT sourcing. The company claims to had a great deal of success with its JIT drive so far, but Barry Waite, vice president and general manager of the East Kilbride plant, admits that there is still a long way to go. As far as Motorola's vendor relationships, Waite stresses his company's commitment to reducing the number of suppliers and establishing long-term relationships with those left. ☐

NCR — Ensuring the vendor is dedicated

Although NCR Ltd. only adopted JIT a year ago, the automatic bank-teller machine (ATM) manufacturing operations are making great strides toward streamlined operations. Already inventory has been slashed by $75,000 (£ 50,000), floor space has been reduced by approximately 400 square feet, product cycle time has dropped from 10 weeks to 10 days and customer order response time has dropped from eight months to six months.

William Patullo, director of manufacturing at NCR (Manufacturing) Ltd., in Dundee, Scotland, puts the improvements down to a combination of both internal applications of JIT as well as JIT relationships with suppliers. The first thing the company did when it introduced JIT back in 1985 was to set up an in-house education program and to draw up a list of projects that would aid in reducing inventory, Patullo says. After the internal program was under way, NCR went to its vendors and established partnerships with them in order to get just-in-time delivery of its higher-cost and higher-volume inputs.

The goal, says Patullo, is to create long-term relationships with a small number of vendors. To encourage JIT sourcing, NCR will provide partnership vendors with 12-month forecasts and six-month rolling forecasts, vendor certification for 100% quality, and provide an agreement for a minimum order quantity of raw materials. The vendor benefits by having secure long-term business, less rework, prompt payment of receipt of goods and improved capacity for business planning.

The pressure to conform to JIT is as intense as the competition to be a JIT supplier. Already NCR has slashed its vendor base by over one-third, from 333 in 1983 down to around 200 by the end of 1986. The fatalities are those companies that refuse to adapt to JIT.

The Scottish Development Agency, Scotland's equivalent of Japan's Ministry of International Trade and Industry (MITI), is attempting to educate local suppliers about JIT. Many believe that if the local supplier does not jump on the JIT bandwagon soon, the business that was once assured will be given to a supplier that complies with JIT sourcing. The result being that the business will be lost — maybe forever. ☐

The competitive advantage: Suppliers must deliver it

Component and production equipment suppliers must do more than develop high-tech products for their customers

By Tim Mead

As much as the fortunes of computer and communications companies rest on their ability to deliver the solutions demanded by their customers, so do those of component- and production-equipment suppliers. They, too, must solve the problems faced by their customers, the IBMs and AT&Ts of the world.

Suppliers are mistaken if they think new bells and whistles alone are enough to sell more chips and testers in 1987. Technology, though a major concern of computer and communications equipment producers, is *not* their biggest problem. It's competition — particularly from abroad.

In a recent survey conducted by ELECTRONIC BUSINESS, 27% of the managers at computer and communications companies who voiced their opinions listed foreign competition as the biggest single issue facing their companies this year. Another 5% singled out domestic competition as their No. 1 concern. "We must become more competitive worldwide," wrote one manager. "Total mismanagement of American manufacturers will create a declining situation," said another.

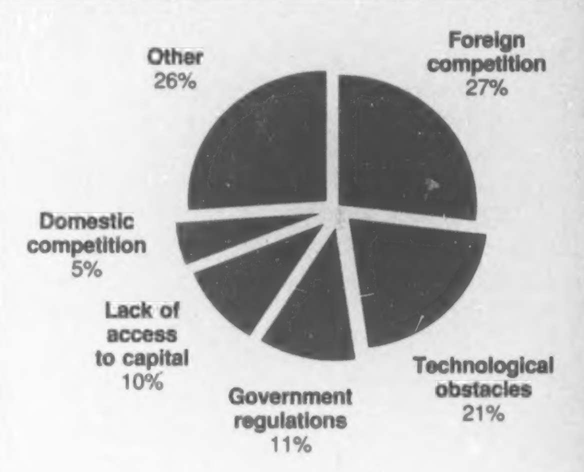
Providing affordable state-of-the-art products to customers is, of course, one way to make them more competitive. And the survey indicates that computer and communications companies will certainly be receptive to any products that can help them surmount technological obstacles.

But suppliers can and *must* do more. They must become competitive on a worldwide basis to continue to provide their U.S. customers the best products at the best price. They must be willing to experiment with new delivery strategies such as just-in-time to help their customers hold down inventory costs. They must provide greater levels of after-sales service to keep their customers' design centers and manufacturing plants operating at peak efficiency.

Suppliers that do not make those extra efforts are going to find themselves out of business. And it may happen sooner than they think. Gone are the salad days when a hardware manufacturer could sell a *Fortune* 1000 customer a machine it really didn't need. Gone, too, is the investment tax credit, a crutch used by many equipment makers to justify outlays for new production equipment.

Here, instead, are tough customers. The buyers of computer and communications equipment demand higher levels of performance for lower prices, transparent networks and the like. They know what they want, and they won't buy anything less. Equipment producers, in turn, are demanding more of their suppliers. They know what they want, too — components and equipment that will make them more competitive. ☐

Major issues facing computer and communications companies in 1987



Source: ELECTRONIC BUSINESS

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Electronic Business

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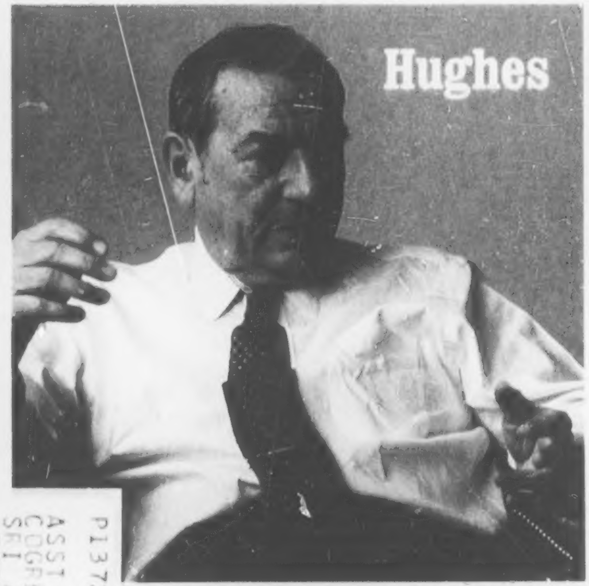

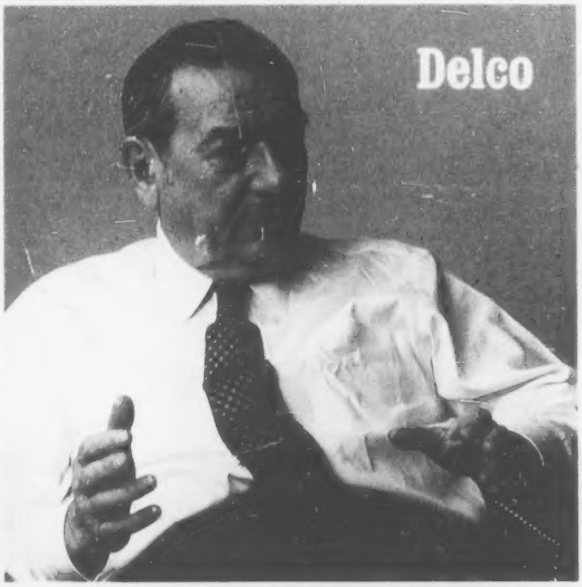

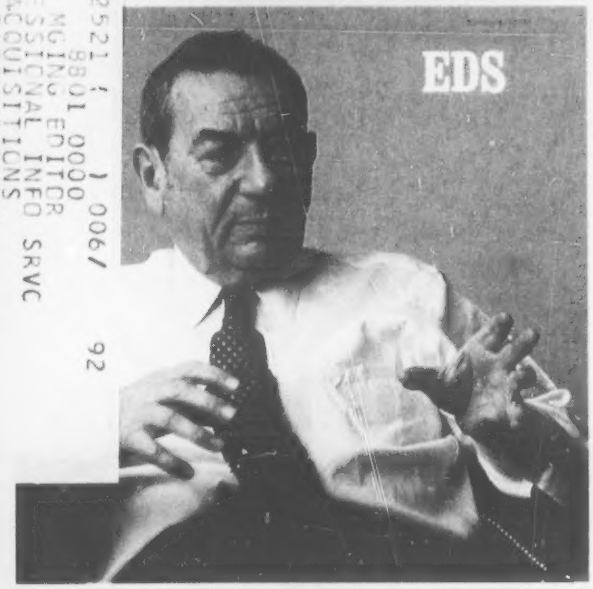

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Cover photo/Robert Burroughs

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Distributors are confident, despite PCBs moving offshore

The movement of PCB production to the Far East doesn't worry distributors. Should it?

Offshore production, a cost-saving tactic increasingly being embraced by U.S. electronic equipment manufacturers, may not devastate industrial distributors as much as it would appear it does.

Sales forecasts for U.S. distributors remain squarely positive in spite of a dramatic rise in the number of equipment makers that are moving their printed circuit board operations to the Far East. The trend would seem to work against distributors, given that they have very little presence in the Pacific Rim.

Nevertheless, optimism abounds for distributors. Their shipments will rise 19% this year and 25% next year, predicts Cahners Economics. They'll grow 12% in 1987 and again as much in 1988, estimates Montgomery Securities. They'll expand 5% to 10%, yearly, figures Arrow Electronics Inc.

What underlies their enthusiasm? Most industry observers and executives contend that the large portion of distribution's customer base is not moving offshore. That base, furthermore, already has suffered a mild recession and is on the road to recovery.

"By and large, the move offshore has not affected distributors because the companies that have moved production out of the United States have been manufacturers of personal computers, disk drives and others. And that's always been an OEM [original equipment manufacturer] business," says Stephen P. Kaufman, president of Arrow Electronics Inc. in New York, explaining that component suppliers usually serve large-run accounts on a direct-sales basis instead of through distributors.

"The markets served by distributors — R&D [research and development] labs, military contractors and manufacturers with short-run production schedules — haven't gone offshore," Kaufman adds. He stresses, however, that the No. 2 distributor has not dismissed the possibility of setting up shop in the Far East. "Arrow always has had a global posture," he says, noting the company already has franchises in Canada, England and West Germany.

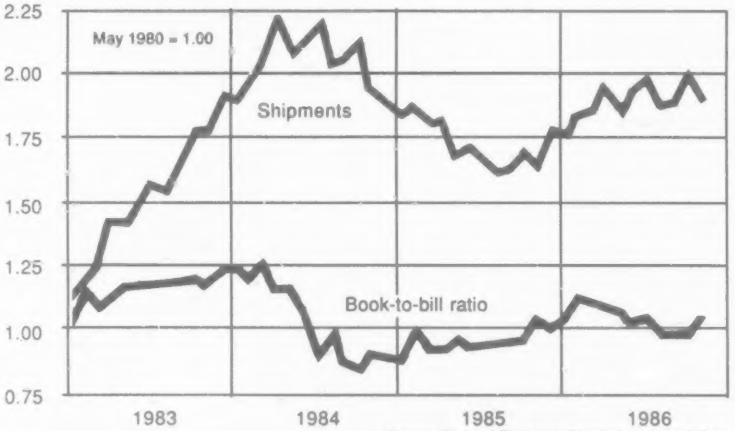
Arrow, like most other top distributors, started to build momentum last fall. Its sales climbed 4% in the third quarter, while Hamilton/Avnet Electronics' rose 10%. Ducommun Inc., Kierulff Electronics' parent, experienced an 11% increase in sales during the three-month period — slightly less robust than the 17% gain in distribution sales at Wyle Laboratories.

Equally significant, most distributors saw their order rates climb in the last few months of 1986. Such activity was reflected in their book-to-bill rates, which hit 1.0 in September and moved upward.

Cahners economist Cheryl Patstone believes that such indexes augur well for the distribution industry this year and next. She says that economic corrections already have occurred in several of the markets served by distributors, notably computer and communications. And she already sees signs of component prices firming — welcome news to Kaufman and other chief executives of distribution companies.

TIM MEAD

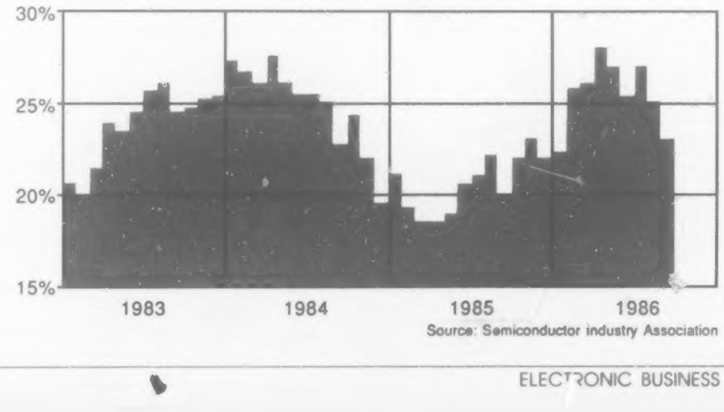
Distribution business index



Source: National Electronic Distributors Association

Distributors' share of IC shipments

(Percentage of U.S./Canadian shipments)



Source: Semiconductor industry Association

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For 1986, production is expected to be up a scant 0.9% from the previous year. This year, steady improvements are forecast thoughout the year pushing production up 3.9%.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.9% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

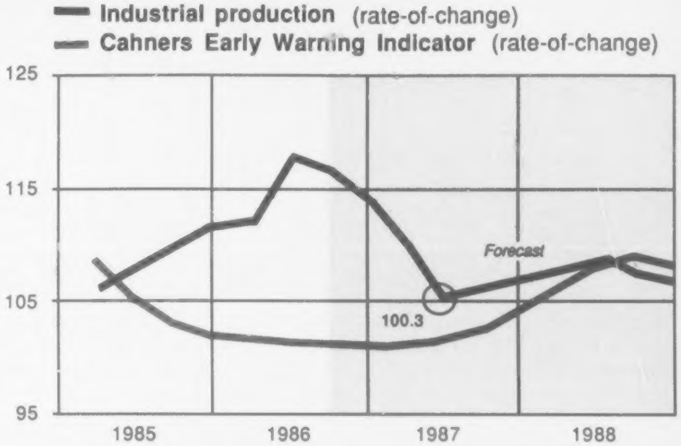
Electronic components

Component production was virtually flat during 1986. In the third quarter, manufacturers increased their levels of output by 0.5%, just enough to compensate for the previous quarter's modest decrease. Early reports for the fourth quarter indicate that production will again show little change. Now that most segments of the industry are recovering from last summer's order slump, we expect production to begin improving gradually. After declining by an estimated 5.1% in 1986, output should rebound 7.7% this year (with the largest gains occurring in the second half). Production will continue to accelerate in 1988, reaching 16.2%.

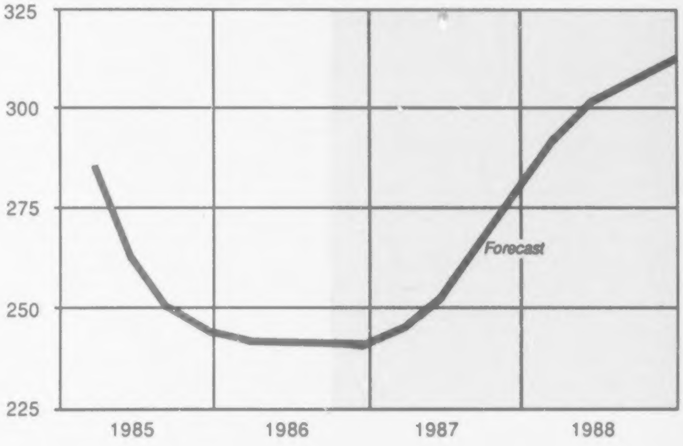
Equipment, instruments and parts

Following three consecutive quarters of improvement, instrument production fell 1% in last year's third quarter. A slowdown in U.S. business investment was largely responsible for that slump with spending cutbacks in 1986 affecting many segments of the instrument industry, including factory automation equipment, and scientific and engineering instruments. Production decreases should continue into early 1987, holding this year's annual growth to just 1.3%, down from an estimated 3.1% gain in 1986. But the market is expected to get back on an expansionary track before midyear, paving the way for a more substantial 9% growth rate in 1988.

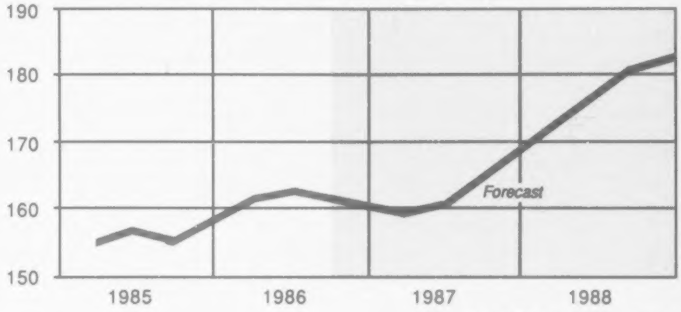
Economic indicators



Industrial production: Electronic components
(1977 = 100, quarterly averages)



Industrial production: Equipment, instruments and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders
Component manufacturers received just $8.72 billion worth of new orders in last year's third quarter, a decrease of more than 14% from the second quarter. This was about double the amount of decline which normally occurs during the summer quarter. The cause of this weakness: lackluster growth in the major end-user markets, which consume large quantities of components; inventory rebuilding by those users, which had given a boost to orders in early 1986, was cut off in the third quarter when business conditions remained disappointing. Orders began to pull out of this slump in the fourth quarter and should continue to rise gradually throughout the coming year. After growing an estimated 5.8% to $38 billion in 1986, orders are expected to increase 12% this year and 21.7% in 1988.

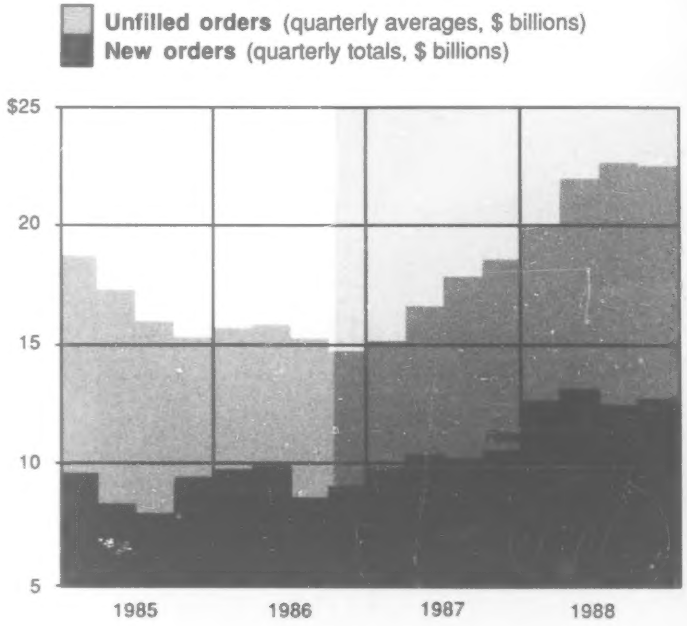
Unfilled orders
Manufacturers' order backlogs averaged $15.6 billion in the third quarter, down from $16.1 billion in the previous three months. A midyear decline in demand for components (resulting from weakness in the capital equipment sector) precipitated the reduction in backlogs. Extended plant shutdowns and continued caution on the part of buyers should prevent backlogs from growing in the fourth quarter, resulting in an overall yearly decrease of 8.3%. But backlogs are expected to build gradually throughout 1987 and 1988 with an increase of 10.7% this year (to an average of $17.3 billion) and 27.4% more next year.

Shipments
Manufacturers' shipments of electronic components were valued at $9.74 billion in the third quarter of 1986, a decrease of about 4.3% from the previous quarter but 4.7% above the level in the third quarter of 1985. Early reports for the fourth quarter suggest that volume will remain close to $9.75 billion. That will bring shipments to a yearly total of $39.5 billion, an increase of 1.6% compared with 1985. The recently reported improvement in orders suggests that shipments will begin to accelerate again by spring (shipments typically turn up 4 to 6 months after bookings). Shipments are expected to increase 6.9% this year and 17.7% next year.

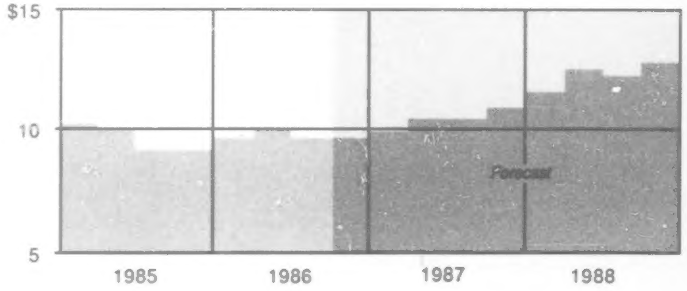
Inventory-to-shipment ratio
The component industry's ratio of inventories to shipments dipped slightly to 1.81 in the third quarter, from a level of 1.83 in the previous three months. These readings fell within the lower third of the range over the last complete business cycle, an indication that there are no severe inventory imbalances in the industry at the present time. As growth in the component market escalates this year, the ratio should be drawn even lower, probably reaching 1.6 to 1.65 by year-end.

Electronic components

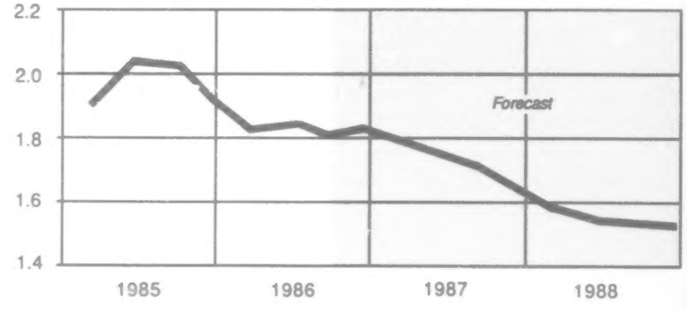
(SIC 367)



Electronic components: Shipments
(quarterly totals, $ billions)



Electronic components: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

When you're No. 6, you have to try harder

Applicon parent, Schlumberger, may be shedding Fairchild, but Applicon continues to make money for the home office

It took staff reductions, lower hardware prices and faithful customers — but Applicon Inc. finally looks as if it may have made money last year for parent Schlumberger Ltd. How much money the CAD/CAM/CAE subsidiary makes this year may depend largely on efforts to win back electronics customers it has neglected in recent years.

Applicon — the No. 6 United States-based vendor of computer-aided design, manufacturing and engineering (CAD/CAM/CAE) systems — was expected to generate more than $2 million in operating profits on $165 million in revenue in calendar 1986. "It's been a long time coming," Applicon president Richard A. Mohrman says of the return to profitability, indicating that his company lost money in 1985 and 1984. During that time, not so coincidentally, Applicon all but abandoned its efforts to sell electronics companies computer-aided design (CAD) systems for making printed circuit boards (PCBs). The company, instead, had been focusing on mechanical CAD applications.

A combination of things has brought Applicon's health back. Mohrman points to three factors: fewer employees — Schlumberger cut 200 workers when it merged Applicon and Manufacturing Data Systems Inc. (MDSI); cheaper computers from its chief supplier — Digital Equipment Corp. (DEC); and steady customers.

Analysts credit the Mohrman's healing powers for the comeback. "He wisely recognized that Applicon wasn't going anywhere by competing head-on with IBM, Computervision and Intergraph at large accounts," says Charles Foundyller, president of market research firm Daratech Inc. in Cambridge, Mass., who figures Applicon company grew about 15% in 1986. "Mohrman repositioned the company to focus on small and medium companies."

He still has his work cut out for him. Applicon acknowledges that it has ignored two major markets in recent years — one defined by industry, the other by geography:

- To correct its shortcomings in selling systems to the electronics manufacturers, which readily bought its DEC PDP-11-based PCB layout systems years ago, Applicon plans to migrate them to newer systems based on VAX or Sun platforms. Mohrman vows that electronics customers will account for 25% of Applicon's sales by 1988; they now represent less than 10% of the subsidiary's business.
- To increase its share of the Asian CAD/CAM/CAE market, which is below 5%, Applicon is expanding beyond its Japanese base. It opened an office in Beijing two months ago, and it intends to open another one early this year in Singapore. "If we can't get 15% or 20% share of that market," Mohrman says of Asia, "we can't manage."

A combination of things has brought Applicon's health back

The issue of management is clearly on the minds of Applicon employees and customers these days. The Ann Arbor, Michigan-based company underwent two major executive changes last year — Mohrman replaced Alex Beavers as president of Applicon, and Michel Gouilloud replaced Jimmy Lee as head of Schlumberger's computer-aided systems group, which Applicon is a part. More disquieting is Schlumberger's proposed sale of its Fairchild Semiconductor unit to Fujitsu Ltd. Some critics wonder whether the entire bloom is off the electronics rose plucked by the late Jean Riboud, who chaired Schlumberger when it acquired Fairchild in 1979, MDSI in 1981 and Applicon in 1982.

Gouilloud assured ELECTRONIC BUSINESS that Schlumberger has no intention of selling Applicon, stressing that it complements the $6.5 billion parent company's wireline, and measurement and control businesses. IBM apparently takes him at his word. It is allowing Applicon to purchase its new 9370 line of minicomputers on an original equipment manufacturing (OEM) basis. Applicon plans to use the IBM machine as a platform for its Bravo3 applications software. Applicon will also continue to offer the software on computers and workstations made by DEC and Sun Microsystems Inc.

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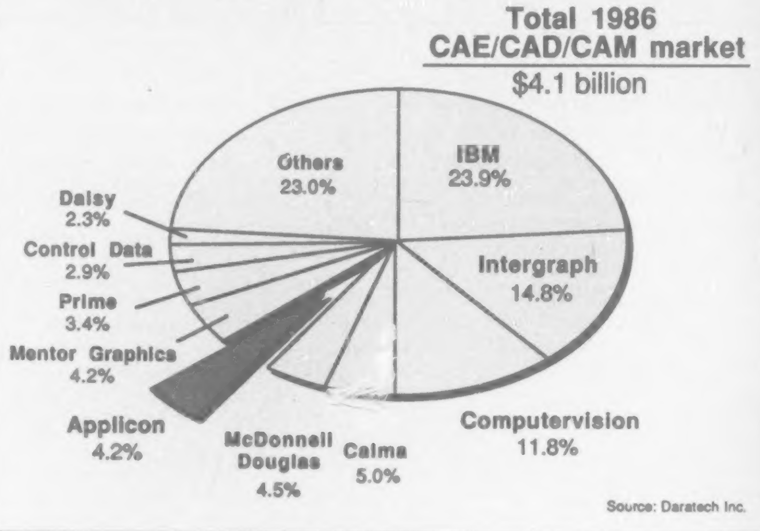
Applicon: Small but finally profitable

Worldwide CAE/CAD/CAM revenue of U.S. companies



Source: Daratech Inc.

Supermini makers set for super year

All the major vendors have introduced new MIPS busters. Now it's a race to the loading dock. How fast is IBM?

By Mary Jo Foley

Even though the rate of new superminicomputer announcements was unusually high last year, the rate of market growth was down. This year, the reverse will be true: fewer new model introductions but greater shipments of existing products.

"We expect demand for superminis in 1987 to go through the roof. The days of hierarchical mainframe computing are over," proclaims Ross Licero, group systems marketing manager for VAX systems at Digital Equipment Corp. (DEC).

Independent market forecasts support Licero's enthusiasm. Worldwide supermini sales will climb 12% to \$17.7 billion this year — up from last year's 8% pace, according to International Data Corp. (IDC) in Framingham, Mass. The market research firm these days refers to superminis as medium-scale systems: 32-bit machines priced between \$100,000 and \$1 million and capable of supporting between 17 and 128 users.

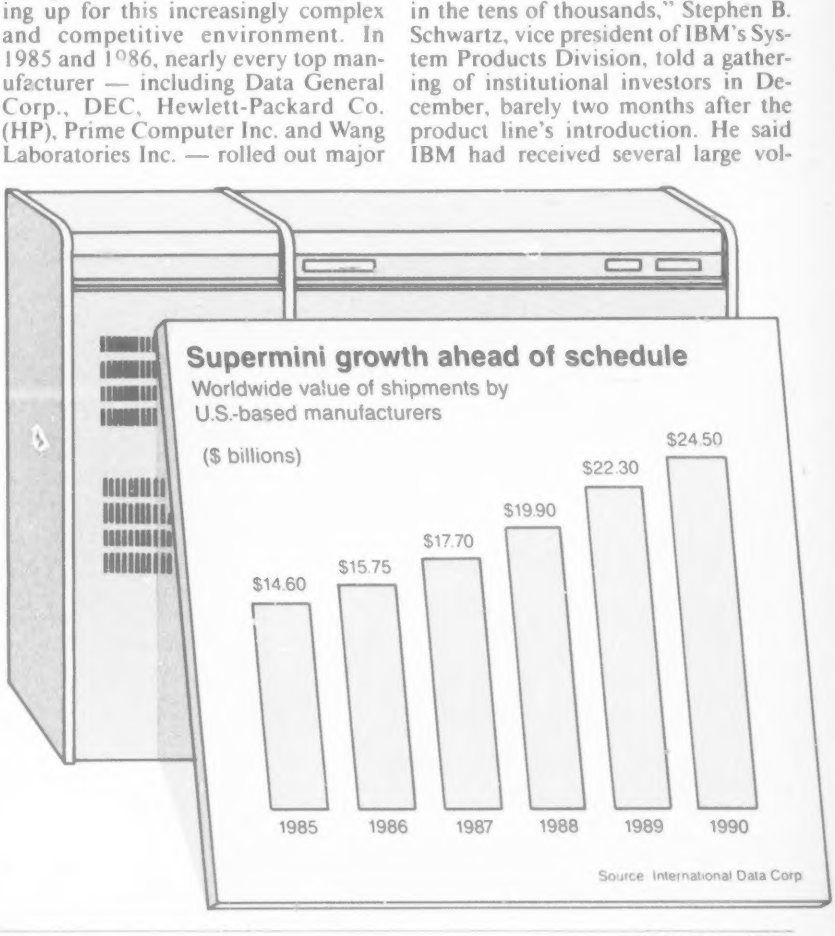
Despite robust demand for superminis, vendors will be scrapping for nearly every sale — against each other and newcomers. All of them have boosted their salesforces, notably supermini leader IBM with the addition of 5,000 employees to its worldwide salesforce of 23,000. At the same time, less established manufacturers of so-called minisupercomputers are vying for a share of the information technology dollars spent by customers for high-performance processing.

Some of the upstarts are relying on cutthroat pricing to get a foot in the door, which may be the wrong tactic. "Price/performance is less important than it's ever been," claims Marc Schulman, a securities analyst for Salomon Brothers Inc. In the eyes of customers, vendor viability, visibility and support are fast becoming the new proving ground for supermini makers. Many, nevertheless, continue to tout the processing speeds of their machines as measured in millions of instructions per second (MIPS).

Ramping up

Supermini makers have been gearing up for this increasingly complex and competitive environment. In 1985 and 1986, nearly every top manufacturer — including Data General Corp., DEC, Hewlett-Packard Co. (HP), Prime Computer Inc. and Wang Laboratories Inc. — rolled out major additions to its supermini line. In addition, IBM last year revamped two of its existing supermini lines, the 4300 and some System/38 models, and introduced a new minicomputer line known as the 9370 Information System. At least two of the 9370 models fit the supermini class, the Model 60 and the Model 90.

"Domestic orders for the 9370s are in the tens of thousands," Stephen B. Schwartz, vice president of IBM's System Products Division, told a gathering of institutional investors in December, barely two months after the product line's introduction. He said IBM had received several large vol-


Supermini growth ahead of schedule
Worldwide value of shipments by U.S.-based manufacturers

Source: International Data Corp.

ume orders from big companies, citing Ford Motor Co. and United Airlines as examples. Most 9370 customers will not receive the machines until the third or fourth quarter of this year, however.

The time lag between product announcements and shipments, coupled with depressed capital spending in 1986, held down the growth of the supermini market last year. But as supermini vendors begin to produce their new lines in volume, the market should climb. IDC predicts worldwide shipments could reach $24.5 billion by 1990.

Competition for established supermini vendors is rising at an even faster rate — from below and above. Second-tier supermini makers such as Concurrent Computer Corp., Gould Inc. and Harris Corp. are targeting market niches with customized machines. Manufacturers of minisupercomputers, array processors and multiprocessors, meanwhile, are expanding their product lines and expertise downward.

Real-time processing and on-line transaction processing, for example, are Concurrent's targets for its 3200 XP products. "I run up against DEC in bidding for real-time jobs, and IBM and Tandem in the OLTP arena," says James Sims, president of $245 million Concurrent, a Perkin-Elmer Corp. spinoff.

To combat such giants, Sims is using different distribution channels and software for each market at present. And he is betting on a new component packaging technology for the future. "The major development in 1987 will be to use surface-mount technology to achieve the density [of processing power] required by the products we have under development," Sims says.

Rivalry among the established supermini vendors is likewise heating up. Price undercutting and discounting are said to be widespread, even though all of the major vendors vehemently deny they participate in these activities. "There are reports some of the competition have given away maintenance [contracts]. And they are trying to mask price discounting to prevent price wars," says Stanley Dolberg, Data General's product manager for midrange superminis.

"Margins in hardware are starting to shrink. And we don't see anything on the horizon to change that," says Fred Wang, president of Wang Laboratories. "That's why we're moving into new areas," he adds, disclosing that Wang intends to decrease its dependency on hardware as a source of revenue from 67% in 1986 to 53% in the early 1990s. Revenue gains in maintenance, services and software will offset the difference.

Battle scars

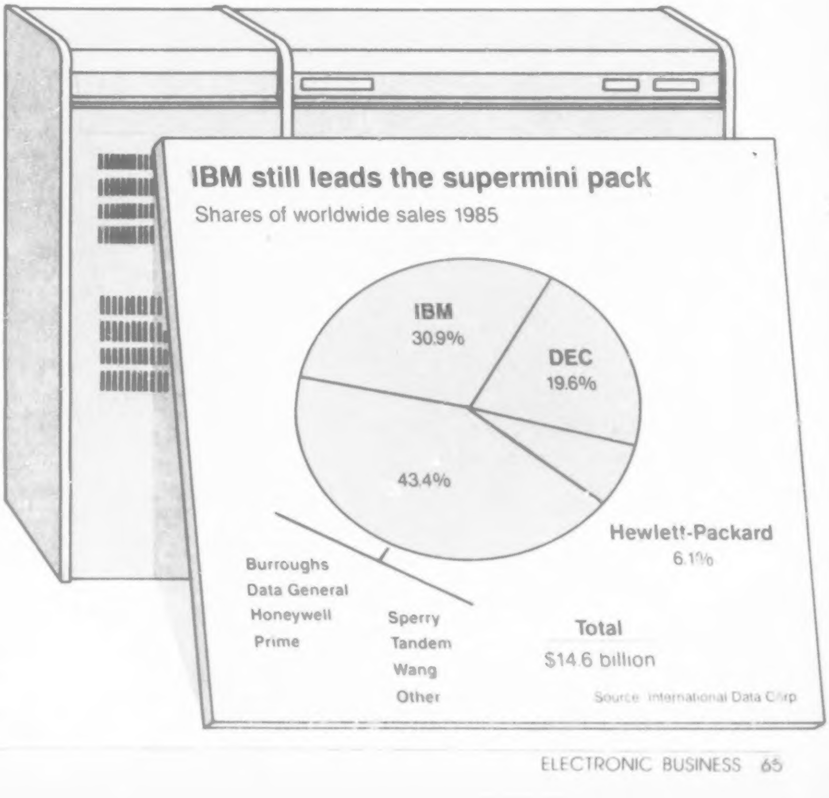
Certain computer manufacturers already have been wounded visibly by toughened-up supermini vendors. "Companies that have tried to play both ends against the middle are hurting," says Marty Grunn of the Sierra Group, a Tempe, Arizona-based market research firm. She identifies these companies as Honeywell Inc., NCR Corp. and Unisys Corp. "They thought departmental [supermini and minicomputer] systems would screw up their mainframe sales." So they emphasized their high ends (mainframes) and low ends (microcomputers), leaving everything in the middle to go its own way.

> "Margins in hardware are starting to shrink. And we don't see anything on the horizon to change that"
>
> Fred Wang of Wang Laboratories

Indeed, such companies are scrambling to correct their computer strategies. Honeywell, for instance, announced at the end of last year it would sell the majority share of its computer business to Groupe Bull and NEC Corp. Another once-feared supermini vendor, AT&T, appears to be backing away from the computer marketplace, despite its protests to the contrary. AT&T in November pulled its direct salesforce off small and medium accounts, leaving such business to value-added resellers and retailers.

The amalgamation of Burroughs Corp. and Sperry Corp. into Unisys further evidences a recognition that new strategies are needed to compete in today's computer environment. Because each company's product lines are largely incompatible, Unisys will continue selling both their supermini offerings: the 5000, 7000 and XE 550 families. "We're choosing to keep all of these products available by choosing specific niches for each," explains Peter Herman, marketing manager for entry-level and distributed systems at Unisys.

The Detroit-based company is relying on Unix for communication between Burroughs and Sperry systems, making it one of the only major supermini vendors (HP is the other) to push



IBM still leads the supermini pack

Shares of worldwide sales 1985

Source: International Data Corp

the nonproprietary, AT&T-developed operating system. Still, fewer than 10% of all superminis currently run Unix, according to market watchers.

Driving forces

As if cutthroat competition was not enough, supermini vendors must rethink their MIPS-based strategies to stay on top, according to analyst Schulman. Customers are paying keen attention to factors other than processing power. "Buying a supermini now is more of a marriage than a simple business decision," he says. "The market is being driven by major corporate users trying to solve networking and [distributed] data-processing problems."

That could spell trouble for vendors lacking cohesive communications and architectural strategies. DEC, committed solely to Ethernet networks and its VAX computer architecture, certainly thinks so. "Those companies with different computer architectures are going to have a difficult time," says John F. Smith, senior vice president of engineering, manufacturing and product marketing at DEC. Counters IBM's Schwartz: "Why do we support different computer architectures? Because our customers demand different solutions."

IBM — at least prior to its June rollout of 103 hardware and software

IMPACT ON ELECTRONICS

Supermini input could raise output

If printer manufacturer Printronix Inc. is any indication, customers will find the new generation of superminicomputers well worth the wait.

The $132 million Irvine, California-based company last August installed a Digital Equipment Corp. VAX 8650 — one of several models that comprise DEC's second generation of VAX minicomputers. The choice of the 6.3 million instructions per second (MIPS) 8650, base price $300,000, was hardly a surprise.

Printronix, like so many customers of second-generation equipment, was a first-generation customer of DEC. Before installing the VAX 8650, the company relied on four VAX-11/750 minicomputers to design its software, firmware and printer hardware, according to management information systems director Victor Fitzsimmons. Now, the VAX 8650 alone is supporting 40 to 50 programmers using various DEC and third-party engineering software-development tools; Anvil computer-aided design software; the Anysis finite-element analysis tool; and Patran, a graphical modeling tool.

Printonix's VAX 8650 interfaces with other manufacturers' systems via DEC's Ethernet local-area network. It is connected to an IBM 4381 mainframe running Management Science America (MSA) Inc.'s integrated business/manufacturing management software; a Telesis printed-circuit-board design system (five workstations connected to Ethernet via a Telesis network); and an Interleaf Inc. computer-aided publishing system (running on four Sun Microsystems workstations).

In addition, Printronix is in the process of connecting its VAX 8650 to other VAX machines at its four remote manufacturing and distribution sites: Camarillo, Calif. (VAX-11/750); Malden, Mass. (VAX-11/750); Singapore (VAX-11/750); and the Netherlands (VAX-11/730).

"It's a way for us to link together all those islands of engineering automation to gain the next level of productivity," Printronix chief executive Robert A. Kleist says of his company's efforts to link all of its VAX hardware together. "We're finally starting to use computers in the computer industry."

Other supermini hardware vendors never were really in the running, as far as Printronix was concerned. "We looked at IBM hardware and a lot of attached processors, like Celerity," Fitzsimmons says. "We also looked at other VAX models. But all the software we use in engineering is written for VAXes. And the 8650 is a fast machine for the money."

M.J.F.

James Caccavo

PRINTRONIX' MIS DIRECTOR VICTOR FITZSIMMONS: "All the software we use in engineering is written for VAXes. And the 8650 is a fast machine for the money" products designed to fill out its somewhat shaky System/36 and System/38 lines — was notorious for its networking and operating-system software compatibility shortcomings. The jury is still out as to how far these enhancements will go toward solving IBM's problems in its midrange computer line.

Market watchers are focusing more intently on Big Blue's newly announced 9370 family. The attention has been far from all positive, despite the fact that the 9370s do significantly extend IBM's 370 computer architecture. The processors reportedly will be capable of speeds from 0.5 MIPS to 2.5 MIPS and priced at $31,000 for the entry-level Model 20, to $190,000-plus for the high-end Model 90. But Gartner Group analyst Craig Symons, for one, forecasts that IBM's price/performance advantage will be smaller than expected once the machines are available later this year. If IBM was counting on the time lag between announcement and shipment putting a damper on its competitors' supermini sales, it was sorely mistaken, both analysts and other supermini vendors agree.

"IBM will sell a lot of 9370s in the coming year to the part of its customer base that won't move to greener pastures," says Schulman. In the meantime, those who refuse to move on "are buying from DEC or not buying at all." Still unaddressed are IBM's office-automation and personal-computer software integration strategies. Adds the Salomon Brothers analyst: "The 9370 announcement is only one step in the right direction."

Customers unruffled

Time lags appear to be having little effect on Hewlett-Packard and other competitors experiencing delays in shipping new products. "We've found that there is some anxiety among our users. People would like to see the machines sooner," HP marketing manager Timothy Haney says of his company's new Spectrum series of minicomputers. Introduced a year ago, after an estimated $200 million development effort, the new machines will not be available to customers until the third quarter of this year. "Generally, people seem willing to wait," he says. "There haven't been any mass migrations [from HP hardware to competitors' machines]."

HP's new Spectrum series is based on a reduced-instruction set architecture (RISC). Products include the HP 3000 Model 930, with a processing speed of 4.5 MIPS and a price tag of $225,000; and the Model 950, at 6.7 MIPS, and priced at $300,000 to $350,000. Due to the difficulty of designing the new computers so they will be able to run the applicatons software written for HP's old machines, neither the 930 nor the 950 is expected to ship before the third quarter of 1987. HP is relying on the current high-end of its 3000 line, the Model 70, to take up the slack until the new models become available. (In May, HP introduced the technical version of its Precision Architecture: the HP 9000 Model 840, which comes in at 4.5 MIPS and $113,500. The 840 began shipping in November.)

HP had little choice but to take a risk on RISC. "Its conventional architecture had plainly run out of steam," says Salomon Brothers analyst Mona Eraiba. Customers do not care about the underlying technology, she says; they are interested in the ease of migration from one architecture to another. So far, it looks as if HP will be able to make this transition fairly smoothly. She also praises the line's other features — notably its multiprocessing capabilities, which speed up a computer's problem-solving tasks by having several processors work on multiple problems concurrently.

> If IBM was counting on the time lag between announcement and shipment putting a damper on its competitors' supermini sales, it was sorely mistaken

HP traditionally has positioned its 3000 products in the commercial arena, though they have sold well into technical applications. It has grander plans for the 930 and 950 models. The systems initially will be targeted at computer-aided design and manufacturing (CAD/CAM), computer-integrated manufacturing (CIM), and general business customers, as well as more specialized technical fields, such as movie animation, seismology and the like.

Like HP, Data General is banking on its new line of superminis to open new markets. The Westboro, Mass., company in December unveiled its MV/15000 series, available for immediate delivery. "It's a bit uncharacteristic for DG — it offers good technical as well as commercial performance," says product manager Dolberg. More in character, the MV/15000 is priced low: $57,200 for the entry-level Model 8 to $204,500 for the high-end Model 20. DG also will target the MV/15000 to its traditional customer bases in healthcare, banking, insurance and petrochemicals.

Not to be outdone

Towering above all the other supermini companies, at least in terms of growth, is DEC. Within the past year and a half, the company rolled out an entirely new VAX line, ranging from the $53,200 VAX 8200 (1.06 MIPS) to the $369,000 VAX 8700 (6.36 MIPS). (Most industry watchers consider its high-end VAX 8800 a mainframe. DEC refers to the $586,000, 12.72 MIPS machine as a supermini.)

"DEC's momentum, if anything, is accelerating," says analyst Schulman. By next fall, the company could debut a multiprocessing version of its new line (dubbed the "MultiVAX"), he predicts, augmenting demand even further. "IBM has a very tenuous lead in departmental computing," adds Sierra Group vice president Grunn. IBM's 9370 announcement might postpone DEC from becoming the premier supermini vendor, but only by a year, she says. Gartner Group's Symons claims DEC already is the No. 1 in terms of supermini revenue.

Demand for DEC's new line, as expected, is obsoleting much of DEC's VAX-11/700 family of computers. What is surprising, however, is the commercial demand created by the new line. Currently, DEC is selling 50% of its VAX 8000s into its traditional scientific/technical stronghold; but the other half is being snatched up by commercial companies. The insurance and education markets have proven especially strong for the Maynard, Mass., company, says DEC's Licero. He claims 20% of DEC customers that buy the VAX 8000s for engineering/scientific purposes are using them for commercial applications; about 14% of all VAX 8000 customers that buy them as commercial processors also are employing them as scientific processors.

"We're struggling to keep up with demand," boasts Licero. "We were in the right place with the right products." If the newly introduced lines of DEC's rivals do even half as well, the supermini market truly may be on its way to a new heyday. ☐

Material handling: When less is more

As capital spending goes, so goes the market for customized material handling systems for electronics manufacturers

By Bruce C.P. Rayner

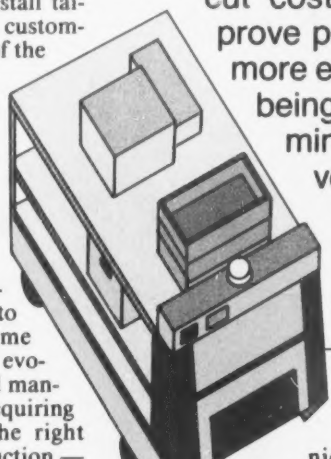
Automated material handling systems — integrated computer-controlled equipment that stores, moves and handles inventory — are big-ticket items. As the electronics industry recovers, investment in such systems is being evaluated more carefully and critically.

As a result, vendors are taking particular care to design and install tailor-made systems to fit their customer's individual needs. Many of the major players — Eaton-Kenway, a division of Eaton Corp., Harnischfeger Industries, Litton Industries Inc., SPS Technologies and Stanley-Vidmar Inc., to name a few — are following this course.

These electronics-oriented material handling systems are partly a response to the revolution of just-in-time manufacturing (JIT) and the evolution of computer-integrated manufacturing (CIM). JIT — acquiring high-quality materials at the right time and right place for production — is convincing managers that inventory of raw materials, work-in-process (WIP) and finished goods must be minimized if costs are to be controlled; CIM provides the practical engineering to accomplish this.

In the early part of the decade, IBM engineers designed the fully automated materials distribution center at Big Blue's Charlotte, N.C., facility and hired Litton and Rapistan, a Lear Seigler company, to install the equipment, says IBM. More recently, IBM teamed up with Litton and Rapistan to install the automated storage, retrieval and handling system that is the bloodstream of IBM's new showcase Proprinter plant in Charlotte.

Lloyd Robertson, vice president of marketing at Litton's Florence, Ky., industrial automation systems group, believes in the need for close cooperation and communication between the vendor and customer in developing a CIM environment. Without communication, he says, the two will end up speaking different languages.



As companies try to cut costs and improve productivity, more emphasis is being placed on minimizing inventory and improving throughput and turnover

At the same time sophisticated material handling systems are gaining popularity, the systems themselves are getting smaller and closer to the production process. As companies try to cut costs and improve productivity, more emphasis is being placed on minimizing inventory and improving throughput and turnover.

IBM's Charlotte distribution center has adapted to the changing times. Since its installation, there has been a tremendous change in attitude toward storage, says Joseph Sullivan, manager of distribution engineering at IBM in Charlotte. Everyone now is acutely aware of the carrying cost of inventory, he says. Compared to when it was designed in 1980, the distribution center now has much higher turn rates and stores a wider variety of parts. Turnover is getting faster and faster, says Sullivan, with material moving more rapidly from the receiving dock to the factory floor.

Team efforts

But the massive material handling jobs that exist today still require enormous resources. So there is a growing tendency for material handling companies to combine forces and bid as consortiums. Many in the industry, including Adolph Kannewurf, director of marketing at Harnischfeger Engineers Inc., a wholly owned subsidiary of Harnischfeger Industries, believe more joint ventures will be seen in the future. The financial and technical synergies, Kannewurf says, make these cooperative efforts appealing.

A recent case in point is the $167 million contract that Harnischfeger Engineers, Eaton-Kenway and Morrison-Knudsen won for a new high-tech distribution center at the New Cumberland Army Depot near Harrisburg, Pa. The joint venture goes under the name of MHK Associates.

The contract, announced last September by the Baltimore office of the Army Corps of Engineers, is for the construction of a 1.8 million square-foot fully automated distribution warehouse, covering 42 acres, to be completed by late 1989. The center, which will house mechanical, electrical and electronic parts, will supply 58% of Army supplies worldwide and 90% of Army stock to the U.S. forces stationed in Europe, says an Army Corps of Engineers spokesman. It is one of three such distribution centers planned: the other two are in California and Texas, the spokesman says. Morrison-Knudsen will build the center while Harnischfeger Engineers and Eaton-Kenway will design and equip the warehouse.

Forecasts differ

Coming off healthy growth rates in the 20s and midteens through much of the past decade, some optimists expect the market for automated material handling equipment to remain buoyant. Others are not so sure that demand for high-tech material handling equipment is still there.

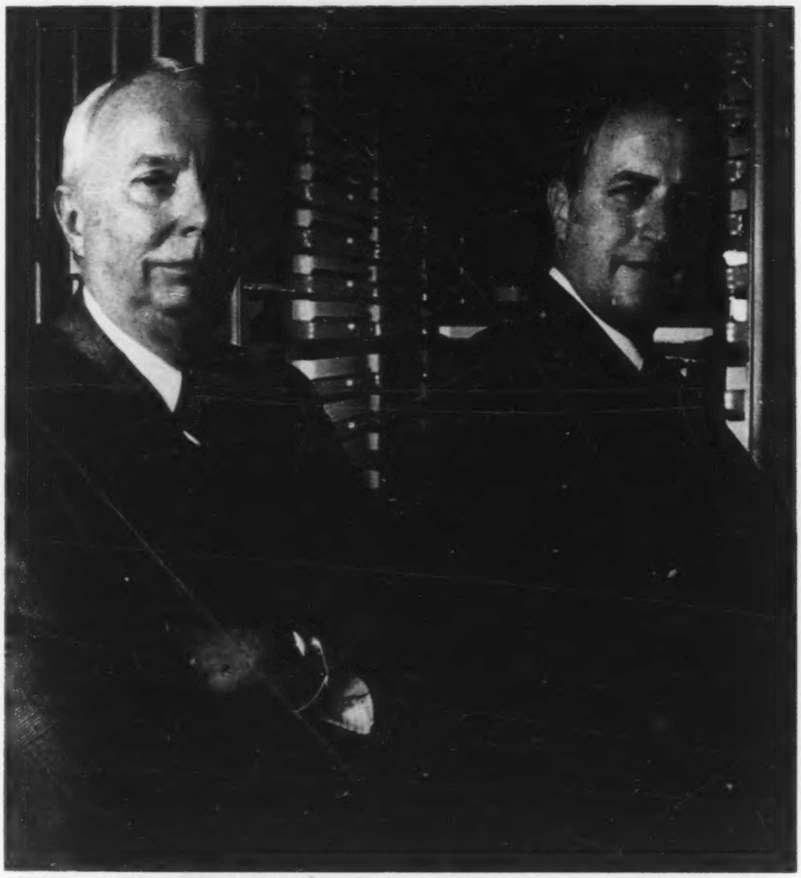
Adam Zais, director of CIM services at International Data Corporation (IDC), for example, estimates the U.S. market for automated material handling equipment — automated packaging and warehousing, robotics, automatic guided vehicles (AGVs) and automated storage and retrieval systems (AS/RS) — to grow to $2.7 billion by 1991, from $1.17 billion in 1986, at an 18.2% compounded annual growth rate.

Robert Goosman, the 1986 president of the Material Handling Institute Inc., the national trade association for the industry, and the president of Stanley-Vidmar's newly acquired automated systems division formally named ESSCORP, believes the compounded annual growth rate for the industry will be between 15% and 18% through the end of the decade.

Zais says that as manufacturers begin to work toward the factory of the future, there will be a fair amount of spending in the automated material handling equipment area. Unlike other areas of CIM, automated material handling equipment offers concrete quantitative benefits and relatively quick payback, comments Zais. The time it takes to design and install these systems is often two years or more. This necessitates careful planning and substantial investment of both human and financial resources.

Education first

As technology penetrates further into the workplace, the need for education at all levels becomes more pressing. Litton is one company that is doing something about teaching and training. The company claims that the key to its market position is the "heavy emphasis on systems analysis, software development, project management and systems integration" together with further developments in automated material handling equipment and flexible manufacturing.



LITTON's LLOYD ROBERTSON (left) and BRIAN SANFORD: The company claims that the key to its market position is the "heavy emphasis on systems analysis, software development, project management and systems integration"

Robert Fleischel/Picture Group

To enhance its role as a market leader in automated material handling systems and to encourage the team spirit, Litton industrial automation systems group is setting up a $10 million technical/education center at its 100-acre Hebron, Ky., facility near the Greater Cincinnati Airport. Brian Sanford, vice president of sales at Litton's automated systems division facility in Hebron insists that "education is a constant part of our selling effort."

"The *Fortune* 100 companies remain our primary customers for automation," says Sanford, and account for about 90% of the group's business. About 99% comes from the *Fortune* 500, he adds. "Five years ago," says Sanford, "many of these companies were buying their first systems, now a lot are learning that they have to buy more carefully next time." Litton is hoping that many of these careful shoppers will take advantage of its new education center.

The center will be completed in April of 1987, says Robertson, and will include a 150-person auditorium, demonstration rooms, laboratories and display rooms. It will show off the latest in automated material handling equipment as well as educate company representatives in all facets of Litton's approach to systems integration.

Erector sets

Goosman of Stanley-Vidmar sees systems integration as a significant market but expects much of the material handling equipment growth to be at the departmental level, initially creating islands of automation. Later, when the equipment is in place, he says, the emphasis will shift to networking the departmental modules together. Goosman sees the evolution of the "erector set" strategy as an important trend in the material handling industry especially for those companies unable to finance a large integrated system. Defined loosely in terms of building blocks, this strategy enables a company to buy integrable automation equipment one piece at a time. The system would grow as the company grows.

Clark Material Systems Technology Co., a division of Clark Equipment

Co., of South Bend, Ind., is following Goosman's erector set strategy. David Hanna, business manager for robotics and AGVs with Clark's technology company, says that the company is targeting the smaller customers and has tried to structure all their products as off the shelf.

Using its 130 dealerships across the country, Clark is marketing off-the-shelf AS/RS, AGVs, robotics and material control systems, says Hanna. The company is getting away from the custom software and big AS/R systems because of the drop in demand, he says. Instead, Clark is focusing on the building-block marketing strategy for smaller customers that want some automation but cannot afford a complete system, Hanna says. Automation is rippling down from the *Fortune* 500 corporations to smaller companies employing 50 to 60 people and it is here that Clark hopes to capitalize, he comments.

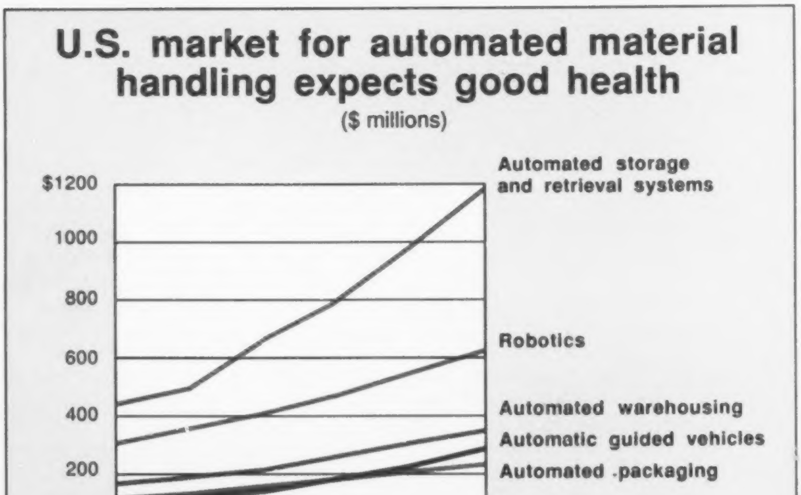
The AS/RS market

One significant component of the automated material handling market is AS/RS — an integrated aisle-rack storage system, computer controlled and serviced by an automatic retrieval machine. IDC expects the AS/RS market to more than double from $450 million in 1986 to $1.2 billion by 1991, at a whopping compounded annual growth rate of 21.7%. This segment consists of both hardware — such as the large unit-loaders that service pallets and the smaller mini- and micro-loaders — and software, both for the equipment and to interface with the factory and inventory control systems, says IDC's Zais.

Other experts, such as Business Trend Analysts (BTA), a Commack, New York-based market forecasting firm, are not as optimistic as either IDC or Goosman, but still see growth. BTA analyst Pauline Kramer says AS/RS will increase at a 13.5% annual rate, from $253 million in 1985 to about $900 million by 1995. Most of the activity will be in the mini- and micro-load systems instead of the bigger unit-load systems, a BTA study reports. Some expect even smaller, more flexible and less expensive equipment, such as horizontal and vertical carousels, to take over from AS/R systems, especially in WIP for electronics companies.

One significant component of the automated material handling market is the automated storage and retrieval systems

A more fundamental question than what size AS/RS, says Woodrow Chamberlain, partner at Arthur Young's manufacturing consulting practice in Chicago, is: "Why am I moving the material in the first place?" Automated material handling equipment and automated storage and retrieval systems, says Chamberlain, are here to stay, but manufacturers are just more cautious about what they buy, and why they buy it.


U.S. market for automated material handling expects good health

($ millions)

Source: IDC/CIMdata, 1986

According to Robertson of Litton, AS/RS and carousels are going to be applied increasingly to WIP on the factory floor and less to large distribution centers as focus shifts from storage of materials to throughput. He expects peripheral equipment, such as robotics, testing equipment and applications of artificial intelligence, to be the most significant area of growth and development in material handling.

One such peripheral market is the automatic guided vehicle market. Zais forecasts AGV growth at a 24.6% compounded annual rate, from $100 million in 1986 to $300 million by 1991. BTA forecasts slower AGV growth at around 13% over the next 10 years.

Hard times ahead?

BTA's figures are more conservative than IDC's, Kramer says, "because of the current deceleration of the entire factory automation industry and less-than-optimal management of installed systems." Richard Walleigh, a principal at Authur Young and Company, a Big Eight accounting firm and management consultant, agrees with Kramer that there has been a lot of mismanagement and suboptimal use of technology in the past. The result is that now, many companies are hesitant to commit themselves to high-tech material handling hardware.

But while some are positive about the future, others are down right pessimistic. Many suspect the industry will be static or experience zero real growth through the end of the decade.

The reason for the expected sluggishness is due to a combination of factors. As Kramer and Walleigh point out, part of the problem is the less-than-optimal past experiences many have had with existing systems. But the less-than-healthy state of the overall economy — including the automotive, areospace and electronics industry — also contributes substantially to the downturn in demand. Whenever hard times hit, capital expenditure (including material handling equipment) goes out the window. ☐

Global sourcing: Once an option, now a necessity

Companies that realize the world is both a market and a source for its products will prosper. Those that don't will fall behind

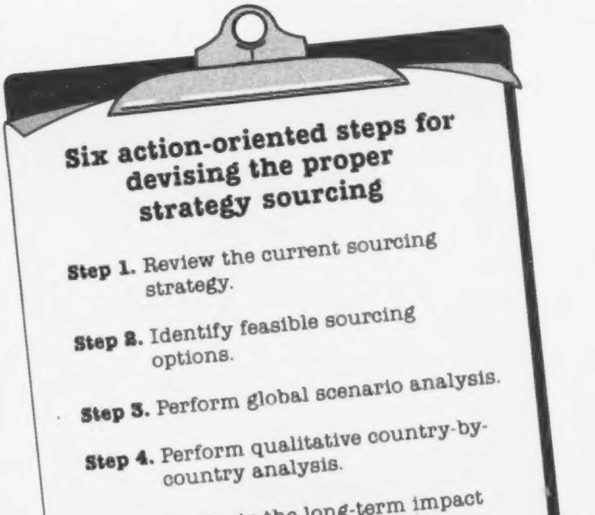
By Roberto Bequillard

The task of determining how and where manufactured goods and raw materials will be procured is so complex that many U.S. electronics companies try to avoid it, blindly relying on purchasing strategies that worked in the past. Sooner or later, however, such companies must recognize that they no longer can afford to dodge the chore. Government initiatives and market forces have made sourcing more important than ever.

The future of the U.S. electronics industry rests on its ability to capitalize on the international opportunities created in recent years by broadened foreign markets for its products; altered economic structures of nations; and improved communication and transportation systems worldwide.

Those developments have had a significant impact on the way in which the industry has traditionally operated, changing the rules by which companies compete today. They have affected almost all of the functional areas of an electronics company's activities, including product development, marketing, manufacturing and finance. As a result, a new dimension of complexity has been added to the managerial decision-making processes aimed at maintaining or improving the company's competitive position.

Roberto Bequillard



Six action-oriented steps for devising the proper strategy sourcing

Step 1. Review the current sourcing strategy.

Step 2. Identify feasible sourcing options.

Step 3. Perform global scenario analysis.

Step 4. Perform qualitative country-by-country analysis.

Step 5. Evaluate the long-term impact of possible sourcing decisions. (To be taken concurrently with Step 4).

Step 6. Develop a strategic plan.

John Kilroy

Where to make it?

Of all the functional areas of the company, manufacturing is one of the most critical activities facing the internationalization challenge. Labor costs are no longer the only major factor driving U.S. companies into the international arena. Proximity to components and material suppliers, industrial infrastructure, flexibility in manufacturing and reliability of quality and delivery are other factors playing a major role in the decision to source internationally.

Global product sourcing, thus, has become a key success factor for manufacturing in the present decade and beyond. Hewlett-Packard Co. and Hitachi Ltd., for example, manufacture equipment and semiconductors in many parts of the world to take advantage of sourcing opportunities. The significant increase in recent years of imports of electronic products and components by U.S. companies — 300% from 1981 to 1985 — clearly indicates the response of manufacturing to this competitive opportunity.

Depending on the specific product category being considered, the impact of the sourcing decision on profitability can vary greatly. But the upside potential of a well designed and implemented sourcing strategy is so enormous that it has become an essential part of the strategic planning process of electronic companies.

Risks, rewards

As with any managerial decision, the risks of offshore sourcing must be carefully evaluated. Concerns about foreign producers' ability to manufacture products of acceptable and consistent quality, reliability of delivery, loss of flexibility and political issues have all been valid reasons for deciding against it.

Those reasons, in some cases, have inhibited the development of a further understanding of the potential benefits of offshore sourcing because they have been presented as obstacles early in the decision-making process at many companies. In other cases, however, companies have succeeded in taking advantage of the opportunity to source offshore without assuming unacceptable risks.

There are still other reasons why companies do not explore offshore sourcing. Many defense contractors and subcontractors, for instance, believe that using parts made abroad is downright illegal. It is not. Depending on the specific country, processes and products involved, sourcing can be and is used as a tool to achieve competitive advantage. In fact, international discussions under way may require a certain percentage of defense products to be imported from such friendly regions as the Caribbean.

Central American and Caribbean countries recently have become important sources of supply to American electronic manufacturers because the region, in many cases, offers greater advantages than other offshore locations, including the Far East. Westinghouse Corp., for example, just announced plans to build a $5 million plant in the Dominican Republic for printed circuit boards.

Westinghouse joins a host of other U.S. electronics companies — Apple Computer Corp., Digital Equipment Corp., GTE Corp., Honeywell Inc., Motorola Inc. and Unysis among others — that have set up operations in the Caribbean. The region is even attracting investment by Japanese and Korean electronics companies as a manufacturing base for their U.S. marketing efforts. Notably, Matsushita Electric has started producing some of its U.S.-bound stereos and radio pagers in Puerto Rico.

Most of the activity is the result of the Caribbean Basin Initiative (CBI), which created a one-way free trade area for companies. Electronics products made in the area have duty-free access to the U.S. market for 12 years. The CBI program, which became effective on January 1, 1984, creates opportunities for direct involvement by U.S. companies in joint ventures, subcontract manufacturing, technology licensing and other types of offshore operations.

Most Caribbean basin countries offer foreign investment incentives such as income tax and customs duty exemptions, factory rentals at concessionary rates, labor training programs and guaranteed repatriation of profits. Many countries have developed foreign trade zones where companies are guaranteed extra freedom from foreign exchange controls and import restrictions.

Twin plants

The Generalized System of Preferences (GSP) and the tariff schedules 806.3 and 807 administered by the U.S. Department of Commerce provide other types of production sharing arrangements. Both provisions allow for duty-free treatment on the value added offshore to products of U.S. origin. They have popularized the twin plant concept used by many manufacturers such as Westinghouse.

Under the concept, product design and engineering activities take place in the United States. The manufacture of primary components is done in low wage countries such as the Dominican Republic or Malaysia. And the high technology finishing operations, such as assembly and testing formerly done in the United States, are now performed in countries having a high-tech infrastructure and a larger composition of skilled workers like Puerto Rico or Singapore.

Other countries, such as India for example, actively seek electronics companies in particular. Recently, the country has modified its incentive programs and has begun rebuilding its infrastructure to achieve this objective. DEC and Honeywell are examples of companies taking advantage of opportunities in India.

Another popular choice is Mexico, especially the border region. The proximity to the United States offers significant advantages — more than enough to offset the higher cost of doing business in Mexico than other foreign countries. RCA Corp., now part of General Electric Co., has a large manufacturing operation in the region, employing 5,700 workers. General Instrument Corp., TDK and Weston Instruments also run border plants.

Helpful steps

Developing a sound sourcing strategy is difficult. It involves the analysis and determination of many controllable and uncontrollable factors that span international boundaries and change over time. It requires an understanding of the interaction between a multitude of measurable variables, an objective assessment of the risks involved and the appropriate balance of those risks with the long-term strategy of the company. All too often, electronic companies typically reach sourcing decisions that do not consider all the most important options.

An effective process for devising the proper sourcing strategy, one that has been used effectively by several electronics companies, links business strategy to product-sourcing decisions. It is a highly structured process involving six action-oriented steps:

- **Step 1.** Review the current sourcing strategy.
- **Step 2.** Identify feasible sourcing options.
- **Step 3.** Perform global scenario analysis.
- **Step 4.** Perform qualitative country-

U.S. companies lean on global sources of supply

U.S. electronics industry imports ($ millions)

Products	1981	1982	1983	1984	1985
Communications	$840	$1,434	$2,586	$3,696	$4,154
Consumer electronics	3,581	3,765	8,356	11,765	14,338
Electron tubes	218	137	276	342	397
Electronic parts	2,045	2,242	3,769	5,339	5,860
Industrial electronics	2,913	3,106	7,111	11,512	12,896
Solid state products	763	1,035	4,980	7,657	5,713
Total	**$10,360**	**$11,719**	**$27,078**	**$40,311**	**$43,358**

Source: Electronic Industries Association

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by-country analysis.

- **Step 5.** Evaluate the long-term impact of possible sourcing decisions. (To be taken concurrently with Step 4.)
- **Step 6.** Develop a strategic plan.

The six-step process presents, in a generic form, a comprehensive approach to developing an efficient product sourcing strategy. The appropriate methodology to be used by each company will depend on the actual situation and limitations of the particular company. Each step may be modified to a company's specific needs.

Who in a company should devise such a strategy? It depends on the size and structure of the individual organization. Product- and market-driven organizations, by their nature, have a larger number of managerial levels making decisions involving multi-functional parameters. In these organizations, the business unit becomes the focal point to evaluate the net effect of sourcing decisions on the final product's cost by considering its impact in all the functional areas. In functionally driven organizations, sourcing decisions are usually made at the corporate level to achieve the same level of integration.

Once a sourcing strategy has been developed, two major activities are still required. It must be implemented. And it must be reevaluated continually to keep current.

Also remember that a global sourcing strategy is only the starting point to the development of a new set of competitive opportunities created by the changes it makes to the current industry structure and the impact it has on the formation, elimination, and displacement of entire industries.

Global sourcing is critcal to the success of many companies in the electronics industry. Together with marketing, technology and control, it is a key factor for achieving competitive success. Marketing and technology develop the right product; sourcing and manufacturing provide it at the right price; and control delivers it to the market at the right time.

If a company does not have a global sourcing strategy and its competitors do, or if it incorrectly implements one, the consequences can be disastrous. If, however, the strategy is properly defined and executed on a timely basis, the potential for achieving competitive success is tremendous. ☐

Bequillard is a senior associate at Theodore Barry & Associates, a management consulting firm based in Cambridge, Mass.

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	0	25	59	8	8	0	8.8	8.1
Pot-Core	0	13	63	12	12	0	10.5	8.2
Laminate (power)	0	28	61	5	6	0	8.0	7.7
CONNECTORS								
Military panel	11	22	45	11	11	0	8.8	9.6
Flat/Cable	23	41	23	9	0	4	5.9	3.9
Multipin circular	0	21	43	36	0	0	9.6	8.9
PC	11	45	33	11	0	0	5.7	6.0
RF/Coaxial	17	50	17	16	0	0	5.4	4.4
Socket	23	53	12	12	0	0	4.4	4.7
Terminal blocks	12	47	29	12	0	0	5.6	4.2
Edge card	9	41	32	14	4	0	7.0	5.5
Subminiature	18	41	23	12	6	0	6.4	6.5
Rack & panel	10	50	20	20	0	0	6.2	5.8
Power	8	23	54	15	0	0	7.4	5.7
PRINTED CIRCUIT BOARDS								
Single-sided	0	65	35	0	0	0	4.8	5.4
Double-sided	0	30	70	0	0	0	6.5	4.3
Multilayer	0	18	65	13	4	0	8.9	7.2
Prototype	0	79	16	5	0	0	4.4	2.7
RESISTORS								
Carbon film	37	33	19	11	0	0	4.2	3.1
Carbon composition	35	38	19	8	0	0	3.9	5.4
Metal film	33	29	29	9	0	0	4.5	3.8
Metal oxide	25	33	42	0	0	0	4.3	5.6
Wirewound	43	43	14	0	0	0	2.4	6.4
Potentiometers	19	33	33	15	0	0	5.9	6.6
Networks	19	29	38	14	0	0	6.1	5.6
FUSES	43	43	14	0	0	0	2.4	3.0
SWITCHES								
Pushbutton	26	44	17	13	0	0	4.7	4.9
Rotary	10	45	35	10	0	0	5.7	5.3
Rocker	26	42	21	11	0	0	4.8	5.0
Thumbwheel	20	40	27	13	0	0	5.4	7.5
Snap action	36	46	9	9	0	0	3.5	4.5
Momentary	37	27	27	9	0	0	4.4	5.4
Dual in-line	20	60	10	10	0	0	4.2	5.5
WIRE AND CABLE								
Coaxial	50	44	6	0	0	0	1.8	3.8
Flat ribbon	59	32	9	0	0	0	1.7	3.6
Multiconductor	47	35	12	6	0	0	2.9	4.0
Hookup	58	38	4	0	0	0	1.5	1.7
Wire wrap	67	33	0	0	0	0	1.0	2.8
Power cords	20	48	28	4	0	0	4.3	4.4
Other	33	17	33	17	0	0	5.8	3.2
POWER SUPPLIES								
Switching	10	37	37	16	0	0	6.5	9.0
Linear	17	50	25	8	0	0	4.8	6.1
CIRCUIT BREAKERS	22	28	39	11	0	0	5.7	6.6
HEAT SINKS	35	35	24	6	0	0	3.9	4.3

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	32	21	37	10	0	0	5.2	6.5
PC board	10	32	32	21	5	0	8.1	8.3
Dry reed	8	33	42	17	0	0	6.9	10.0
Mercury	0	29	57	14	0	0	7.6	11.0
Solid state	8	31	31	23	7	0	8.9	8.2
DISCRETE SEMICONDUCTORS								
Diode	39	18	39	0	0	4	4.8	4.5
Zener	39	9	35	17	0	0	5.7	4.9
Thyristor	27	7	53	13	0	0	6.5	6.4
Small signal transistor	35	20	30	15	0	0	5.3	7.1
FET, MOS	13	20	53	7	7	0	7.6	7.8
Power, bipolar	15	39	46	0	0	0	4.8	4.5
INTEGRATED CIRCUITS, DIGITAL								
CMOS	23	31	27	15	4	0	6.4	7.6
TTL	26	22	39	9	0	4	6.5	4.7
LS	32	18	39	7	4	0	5.7	5.0
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	25	12	50	13	0	0	6.3	7.9
OP amplifier	10	37	37	16	0	0	6.5	8.0
Voltage regulator	14	33	34	19	0	0	6.6	6.8
MEMORY CIRCUITS								
RAM 16k	14	57	29	0	0	0	4.0	8.4
RAM 64k	17	50	33	0	0	0	4.2	6.7
RAM 256k	18	46	27	19	0	0	5.0	7.7
ROM/PROM	0	55	45	0	0	0	5.3	8.0
EPROM	14	41	27	14	0	4	6.9	7.3
EEPROM	8	31	46	8	0	7	8.2	8.3
DISPLAYS								
Panel meters	9	46	27	18	0	0	6.4	5.7
Fluorescent	0	29	43	14	14	0	10.1	10.0
Incandescent	0	75	25	0	0	0	4.3	9.3
LED	9	54	23	14	0	0	5.6	5.9
Liquid crystal	0	39	46	15	0	0	7.2	8.7
MICROPROCESSOR ICs								
8-bit	20	53	20	7	0	0	4.2	7.3
16-bit	20	70	10	0	0	0	2.9	8.2
FUNCTION PACKAGES								
Amplifier	0	63	37	0	0	0	4.9	8.3
Converter, analog to digital	0	39	38	15	8	0	8.6	10.8
Converter, digital to analog	0	40	40	10	10	0	8.5	10.7
LINE FILTERS	0	50	38	12	0	0	6.4	7.5
CAPACITORS								
Ceramic	23	41	21	15	0	0	5.2	4.9
Ceramic monolithic	20	40	25	15	0	0	5.5	5.4
Ceramic disc	27	31	27	15	0	0	5.5	5.8
Film	21	24	45	10	0	0	5.9	6.7
Electrolytic	19	37	18	26	0	0	6.6	6.3
Tantalum	15	37	26	22	0	0	6.6	7.2
INDUCTORS	8	38	54	0	0	0	5.5	6.6

Source: *Electronics Purchasing* magazine's survey of buyers